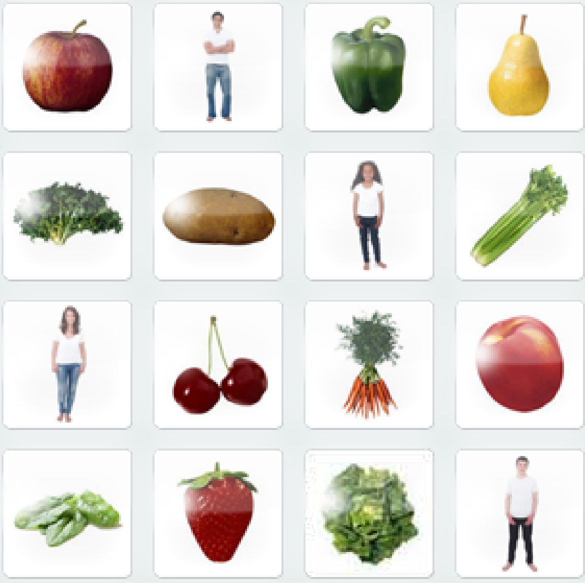
PERSPECTIVE ON PESTICIDE RESIDUES IN FRUITS AND VEGETABLES



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PESTS AND OUR FRUITS AND VEGETABLES

Farmers who choose to provide fruits and vegetables to increasingly large numbers of consumers recognize particular insects, mites, weeds, nematodes, disease-causing organisms, and vertebrates as competitors that may lower the quality and yield of their produce. Managing pests for crop protection has been a continual challenge wherever agriculture has been practiced. The ageless competition between insects and humans was described by Forbes in an Illinois State Laboratory Bulletin in 1915 as follows:

> "The struggle between man and insects began long before the dawn of civilization, has continued without cessation to the present time, and will continue, no doubt, as long as the human race endures. It is due to the fact that both men and certain insect species constantly want the same things at the same time. Its intensity owing to the vital importance to both, of the things they struggle for, and its long continuance is due to the fact that the contestants are so equally matched. We commonly think of ourselves as the lords and conquerors of nature, but insects had thoroughly mastered the world and taken full possession of it long before man began the attempt."

The widespread introduction of synthetic organic pesticides into crop protection in the 1940s allowed reduction of pest abundance and pest damage to levels that were not previously possible. Plant breeding, fertilization, irrigation, and pesticide technologies are characteristics of the world's most productive agriculture in spite of the continuing presence of pests. Since 1900 Americans spend 50% less of their income to feed themselves (Food Marketing Institute 1994). A National Academy of Sciences estimate (NRC 1991) of disposable income of a typical American family indicated that approximately 10% is used to purchase food, lower than any other country (CAST 1992). These data prompt the suggestion that a major benefit of pesticide use is an abundant supply of nutritious produce.

Pests do not distinguish whether fruits and vegetables are produced in conventional or organic agriculture. When pests threaten the farmer's ability to market produce for profit, pesticides may be a means to protect the food for human consumption.

PESTICIDE REGULATION IN CROP PROTECTION

All aspects of pesticide use in modern agriculture are highly regulated. That doesn't make the process perfect, but pesticide regulation is a very transparent process to both scientists and the public. The first pesticide registration laws in 1910 were primarily aimed at protecting consumers from ineffective products and deceptive labeling. The laws regulating pesticide use are based upon two laws. In 1938 the Federal Food, Drug and Cosmetic Act (FFDCA) that enabled enforcement of tolerances was passed. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was first passed in 1947. It established procedures for registering pesticides with the U.S. Department of Agriculture and established labeling provisions and tolerances.

FIFRA was rewritten in 1972 when it was amended by the Federal Environmental Pesticide Control Act (FEPCA). The law has been amended numerous times since 1972, including some significant amendments in the form of the Food Quality Protection Act (FQPA) of 1996.

PESTICIDE SAFETY EVALUATION AND RISK CHARACTERIZATION

Toxicologists conduct carefully designed and controlled studies to reveal the nature and extent of potential toxic effects of pesticides in humans. Hazard Identification or safety evaluation studies reveal the inherent toxicological properties of chemicals. Further characterization of qualitative and quantitative responses to the pesticide is defined by Dose-Response Relationships. Safety evaluation studies are guided by the fundamental tenet of toxicology that there is a dose level for any chemical that will not produce a response.

The importance of a threshold "no effect level" of exposure is explicitly described by Health Canada (2008) as follows: "Most responses elicited by a substance, including acute toxicity, chronic toxicity, neurotoxicity, irritation, developmental toxicity, and reproductive toxicity are considered threshold in nature. Endpoints [Responses] that have been observed to lack a threshold response (e.g. genetic toxicity, carcinogenicity) are assumed to result in an increase in risk at any level of exposure and hence are subject to different risk assessment methodologies."

The experimental dose level at which no adverse effects are observed is the No Observed Adverse Effect Level (NOAEL; mg chemical/kg body weight laboratory animal). The lowest dose at which adverse effects were observed in a particular study is the LOAEL. An adverse effect is "a change in morphology, physiology, growth, development, or lifespan of an organism which results in impairment of functional capacity to compensate for additional stress or increase in susceptibility to the harmful influences of other environmental influences (International Programme on Chemical Safety, 1994)."

Evaluation of the toxicological database for a particular pesticide will identify NOAELs associated with different tests. NOAELs associated with short-term (acute) dietary exposures related to the potential consumption of fruits and vegetables containing pesticide residues are used in the comparative data reported here.

PESTICIDE RESIDUE TOLERANCES

Before EPA can register a pesticide for crop protection, it must grant a tolerance. A tolerance is the maximum amount of a pesticide that can be on a raw product when it is used and still be considered safe. Tolerances are based upon use of the pesticide product in accord with good agricultural practices. Tolerances are established under conditions that maximize the potential for residues. Controlled field trials use the maximum rate permitted on the label, the maximum number of applications, and the minimum pre-harvest interval (the number of days between the last application and harvest). The FFDCA requires EPA to establish these residue tolerances based upon the specific uses of a pesticide product.

The 1996 FQPA amended the FIFRA and the FFDCA. Among other changes, FQPA established a health-based standard ("a reasonable certainty of no harm") for pesticide residues in food to assure protection from unacceptable pesticide exposures. Actual crop residues of registered pesticides are almost always well below established tolerances, exceptions representing trace residues resulting from drift, carry-over soil residues from previous applications, or rarely illegal pesticide use.

PESTICIDE DATA PROGRAM OF THE U.S. DEPARTMENT OF AGRICULTURE

Fruits and vegetables that are marketed following use of pesticides in conventional or organic crop protection may contain trace levels of residues. The amounts are too small to be listed among Food Facts on ingredient labels, but many can be measured by sensitive analytical procedures available in regulatory, university, and industry laboratories. By law, they must be less than tolerances and, in practice, pesticide residues are usually much less than that regulatory standard.

In 1991, the United States Department of Agriculture (USDA) was charged with designing and implementing a program to collect data on pesticide residues in food. Responsibility for this program was given to the USDA Agricultural Marketing Service (AMS), which began operating the Pesticide Data Program (PDP) in May 1991. The data produced by PDP are reported in an annual summary. Those measurements can be used to estimate consumer exposure and the relationship of those exposures to science-based standards of safety. The reasonable certainty of no harm to human health can be applied to any of the trace pesticide residues in produce.

EWG SHOPPER'S GUIDE DOESN'T DELIVER

An Environmental Working Group Public Affairs June 1, 2010, press release proclaims that "Environmental Working Group delivers the sixth edition of its Shopper's Guide to Pesticides with updated information on 49 fruits and vegetables and their total pesticide load." The claim and the content of the Shopper's Guide can not be used to reliably rank fruits and vegetables based upon how much residue is present on produce, the common-sense determinant of risk. The Shopper's Guide simply doesn't deliver!

The EWG claims to use "a detailed description of the criteria EWG used to develop these rankings…" based upon PDP data from 2000-2008. With respect to methodology the EWG reports:

Contamination was measured in 6 different ways:

1. Percent of samples tested with detectable pesticides
2. Percent of samples with two or more pesticides
3. Average number of pesticides found on a single sample
4. Average amount (level in parts per million) of all pesticides found
5. Maximum number of pesticides found on a single sample
6. Total number of pesticides found on the commodity

"Crops were ranked based on a composite score from all categories. The goal is to include a range of different measures of pesticide contamination to account for uncertainties in the science. All categories were treated equally." Repeated attempts to engage EWG representatives in discussion of how composite scores are calculated have been unsuccessful. They claim that the methods are proprietary. Doubtless EWG recognizes that "THE POWER OF INFORMATION" carries an obligation to inform.

The claim that the Shoppers' Guide shows the fruits and vegetables with the most and least pesticides is erroneous and not supported by published EWG Methodology or personal correspondence with staffers. The PDP database 2000-2008 and the ranking system used by EWG can not distinguish produce based upon "most and least pesticides". The list is not about potential dose as it is so widely touted to be by EWG and others. They define likelihood of exposure based upon the number of times a residue at any level is detected as a produce residue. However, dose, the fundamental determinant of risk, is not synonymous with their definition.

The Shopper's Guide based upon counting the numbers of residues on fruits and vegetables may simplify Dr. Weil's shopping since he opts for organic fruits and vegetables, but what about the usefulness of the Guide for persons who propose to use it to reduce their "pesticide load"?

If the EWG Shopper's Guide gives meaningful information to consumers to guide their selection of fruits and vegetables, then using the guide to reduce pesticide exposure should produce a meaningful benefit.

OUR METHODOLOGY

We asked, "What is the extent of human exposure resulting from consumption of fruits and vegetables that contain trace pesticide residues relative to no observed adverse effect levels (NOAELs) of exposure established in well-designed, safety evaluation studies?" An extreme case example was prepared to illustrate the relationship between consumption of produce containing a high pesticide residue and the no effect level of that residue in consumers. This example utilizes 14 of the 49 types of produce on EWG's list. Since consumption varies with age and gender, both were considered regarding serving sizes for each group of consumers. An extreme case example was built using the following information:

1. The highest pesticide residue for the food in ppm (μg/g) was selected from the PDP database, 2000-2008. (If a dietary NOAEL was not assigned by USEPA to that residue based upon lack of any short term toxicity, the second highest residue pesticide with a dietary NOAEL was chosen for the example in the Table.)
2. The dietary NOAEL from the Registration Eligibility Decision or other US EPA documents is expressed in mg/kg body weight/day.
3. Consumer specific body weights (kg) were assigned based upon USEPA estimates.
4. The age and gender-specific average serving size for children (2y-5y; 20 kg or 44 lbs), teens, and adult females and males from USDA Foods Commonly Eaten in the U.S. (1994-1996)
5. The Number of Servings equivalent to the NOAEL was determined using the following calculation:

Equivalent Servings = NOAEL x Body Weight x 1000/(residue ppm x serving size)

6. The residues listed in the Table are the highest ones found during 2000-2008. They are each less than the specific tolerances for the respective pesticides--maximum safe levels of pesticide permitted on produce. When the residue levels are transformed to potential exposures based upon average servings equivalent to the No Effect Level of exposure, a common sense safety factor is clearly demonstrated. As shown in the Table, consumption of hundreds to thousands of average servings are required to represent *no effect levels* of pesticide exposure at the very highest residues measured for each pesticide in each crop.

CONCLUSION

Shoppers are urged to take a careful look at the EWG classification scheme. It is determined by the number of residues (not amount) occurring in produce in the USDA Pesticide Data Program samples. EWG and uncritical media transform the EWG numbers into a notion of potential consumer exposure. For the residues that occurred in the highest amounts of all in the USDA's PDP data from 2000-2008, hundreds to thousands of servings of fruits or vegetables in a single day are required of children, teens and adults to represent a dosage equivalent to the NOAEL! When it comes to exposure, the Shopper's Guide doesn't deliver!

No Effect levels of pesticide exposure can be assigned to produce at any position in the EWG ranking system from number 1 to 49. It is groundless to suggest that the Shopper's Guide can be used to meaningfully predict risk. The testing that is used to identify the inherent hazards of pesticides also yields a measure of exposure that is not associated with any detectable adverse effects (toxicity). The pesticide exposures that result from consumption of hundreds to thousands of servings of produce with the very highest residues measured represent ***no effect levels of exposure.***

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Servings of Fruits and Vegetables Equivalent to a NOAEL Dose at the Highest Reported Residues, USDA: Pesticide Data Program, 2000-2008

Commodity	Highest PDP Residue	Residue in parts-per-million (µg/g) [c]	NOAEL Dose (mg/kg-bw/day) [d]	Consumer	Body weight (kg-bw)	Servings Equivalent to the NOAEL[e]
Apple	Thiabendazole	7.0	10	Child (2-5y)	20	154
				Teen (12-19)	40	298
				Woman	50	529
				Man	70	571
Blueberry	Carbaryl [b]	1.7	1.1	Child (2-5y)	20	175
				Teen (12-19)	40	233
				Woman	50	219
				Man	70	306
Carrot	Linuron	0.33	25	Child (2-5y)	20	56,117
				Teen (12-19)	40	86,580
				Woman	50	99,681
				Man	70	151,515
Celery	Chlorothalonil [b]	0.9	31	Child (2-5y)	20	98,413
				Teen (12-19)	40	91,852
				Woman	50	123,016
				Man	70	133,951
Cherry [a]	Tebuconazole	1.3	3	Child (2-5y)	20	669
				Teen (12-19)	40	888
				Woman	50	836
				Man	70	1,171
Kale [a]	Permethrin	8	25	Child (2-5y)	20	1,838
				Teen (12-19)	40	2,500
				Woman	50	2,332
				Man	70	3,265
Lettuce	Azoxystrobin [b]	2.2	67	Child (2-5y)	20	11,713
				Teen (12-19)	40	13,687
				Woman	50	10,877
				Man	70	15,227
Nectarine	Formetanate Hydrochloride [b]	0.74	0.65	Child (2-5y)	20	338
				Teen (12-19)	40	395
				Woman	50	314
				Man	70	439
Peach	Carbaryl [b]	1.9	1.1	Child (2-5y)	20	176
				Teen (12-19)	40	206
				Woman	50	263
				Man	70	318
Pear [a]	Thiabendazole [b]	2.9	10	Child (2-5y)	20	851
				Teen (12-19)	40	1,140
				Woman	50	1,071
				Man	70	1,499
Potato	Chlorpropham	11	250	Child (2-5y)	20	6,494
				Teen (12-19)	40	5,981
				Woman	50	7,379
				Man	70	12,626
Spinach [a]	Permethrin	13	25	Child (2-5y)	20	2,564
				Teen (12-19)	40	3,344
				Woman	50	3,205
				Man	70	4,487
Strawberry	Captan	5.1	10	Child (2-5y)	20	1,508
				Teen (12-19)	40	1,743
				Woman	50	2,042
				Man	70	2,640
Sweet Bell Pepper	Acephate	1.8	0.5	Child (2-5y)	20	1,111
				Teen (12-19)	40	855
				Woman	50	817
				Man	70	845

[a] When serving sizes were not found in Foods Commonly Eaten in the U.S. (1994-1996), USDA National Nutrient Database for Standard Reference was used.

[b] If a dietary NOAEL was not assigned by USEPA to the highest residue based upon lack of any short term toxicity, the second highest residue pesticide with a dietary NOAEL was chosen for the example in the Table

[c] The highest residue found in USDA PDP, 2000–2008

[d] Dietary NOAEL obtained from Reregistration Eligibility Decision or other US EPA documents.

[e] Equivalent Serving = NOAEL (mg/kg-bw/day) × Body Weight (kg) × 1000/1000 / (ppm (µg/g) × Serving Size (g))