

## Is Organic Healthier? The Science Supporting Organic Foods



**Charles M. Benbrook Ph.D.**  
**Kathleen Merrigan Ph.D.**  
**Dr. Alan Greene**

**Natural Products Expo East**  
Washington, D.C.  
October 15, 2004

## Overview of Session

### Chuck Benbrook

- Organic Center 101
- Release of the Executive Summary, Pesticide Residue State of Science Review

### Dr. Alan Greene

- Off to a Healthy Start: Why Mothers Should Seek Out Organic Food

### Kathleen Merrigan

- Overview of Organic Center work on antioxidants and polyphenols

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Organic Center 101

## Our Mission

...to promote research and science-based consumer education on the human health and environmental benefits of organic food and farming systems.



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## The Challenge

More and better scientific evidence is needed to prove and quantify the many different benefits that are associated with organic food and farming systems.



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## Science-Side Activities

- State of Science Reviews (SSRs)
- Identifying research priorities and finding ways to initiate and fund priority projects
- Highlighting "Hot Science"  
<http://www.organic-center.org/science.htm?groupid=8>



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## Consumer-Side Activities

- Tracking consumer attitudes, interests, and understanding of the organic benefit
- Providing information that brings home to people the nature of the organic benefit



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## Consumer-Side Activities, cont.

- Helping organic farmers, food companies, and the retail sector communicate the latest scientific findings in clear and meaningful ways



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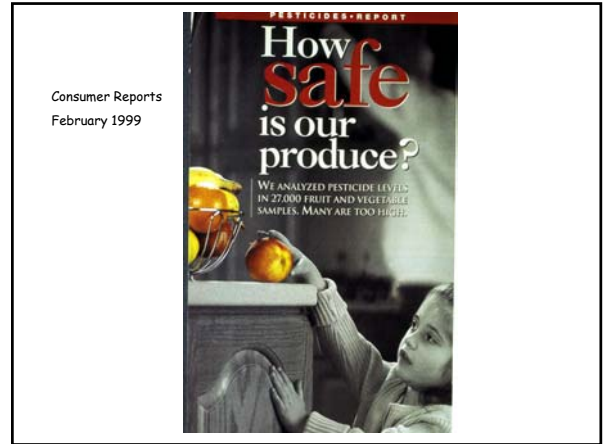
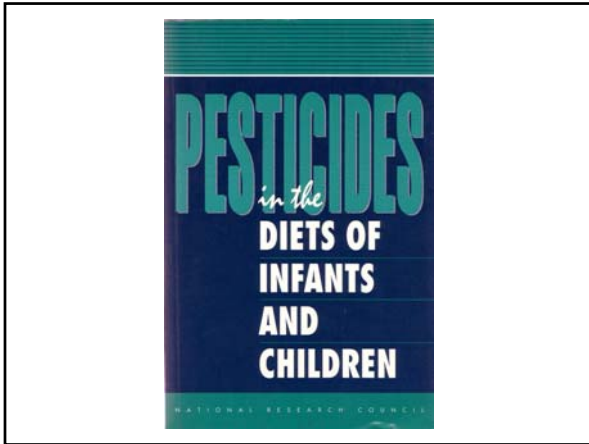
## Who Guides the Work of the Organic Center?

- 14 member Board of Directors  
<http://www.organic-center.org/about.htm>
- 26 member Scientific and Technical Advisory Committee (STAC)  
<http://www.organic-center.org/about3.htm>
- 25 member Communications and Education Committee (C&E)



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### New FAO-UNEP-WHO Report

- 1-5 million kids are poisoned every year
- 99% of deaths are in developing countries
- Malnutrition and dehydration increase susceptibility

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### Differences in pesticide risk from dietary exposure are a function of:

1. Frequency of residues (e.g., percent of samples testing positive)
2. Number of residues per sample
3. Residue levels found
4. Toxicity of the pesticide

*Pesticide Dietary Exposure SSR presents data on 1-3. Other SSRs will cover toxicity issues.*

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### Pesticide Dietary Exposure SSR

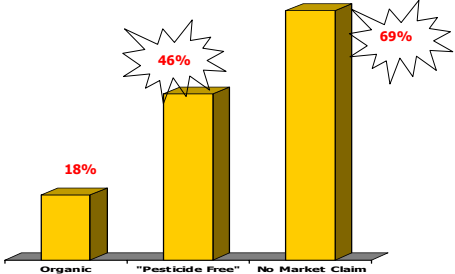
#### Comparison of pesticide residues in conventional and organic foods

- by type of food
  - ✓ Fruits, Vegetables, Processed Foods, Grains, Milk/Meat based foods
- by year
  - ✓ 1993-2002, 2002
- by country of origin – domestic and imported

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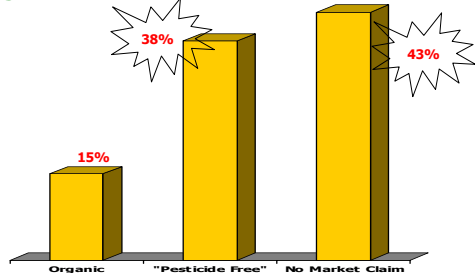
### Frequency of residues: Fresh fruits, vegetables & processed foods, 1993-2002 PDP



| Category         | Frequency of Residues |
|------------------|-----------------------|
| Organic          | 18%                   |
| "Pesticide Free" | 46%                   |
| No Market Claim  | 69%                   |

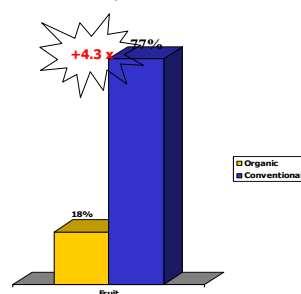
Source: Pesticide Data Program (PDP) 1993 - 2002; Benbrook Consulting Services/EcoLogic, 2004

### Frequency of Residues: Fresh Fruits, Vegetables & Processed Foods, 2002 PDP



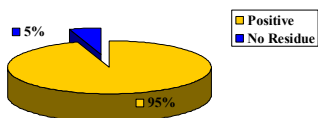
Source: Pesticide Data Program (PDP) 2002; Benbrook Consulting Services/EcoLogic, 2004

### Frequency of residues in organic and conventional fruit, PDP 2000-2002



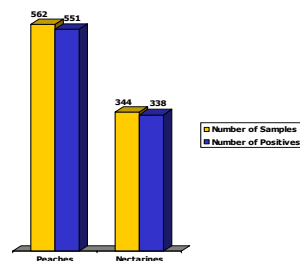
Source: Pesticide Data Program (PDP) 2000 - 2002; Benbrook Consulting Services/EcoLogic, 2004

### Positives samples in fruit, PDP 1993-2002



Source: Pesticide Data Program (PDP) 1993 - 2002; Benbrook Consulting Services/EcoLogic, 2004

### Frequency of residues in conventional peaches (2002) and nectarines (2000), PDP



Source: Pesticide Data Program (PDP) 2000 - 2002; Benbrook Consulting Services/EcoLogic, 2004

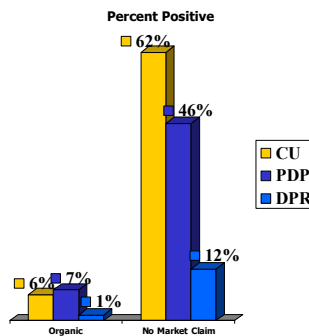
### Multiple Residues

- are surprisingly common
- increase the chances of additive/synergistic health effects
- must be taken into account to accurately assess health risks



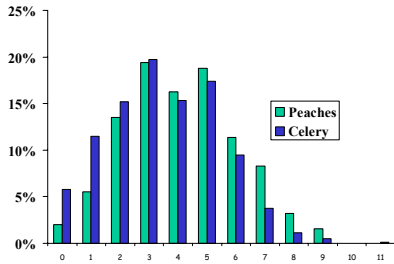
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### Multiple residues in three datasets



Source: Baker et al., Food Additives and Contaminants, 2002, Vol 19, No. 5, 427-446

## Multiple residues in peaches and celery, 2002 PDP



## What are the odds?



A consumer buying conventional peaches is >11 times more likely to choose fruit with 7 or more residues than fruit with no residues.

Average peach had 4.25 residues



Celery: Five or more residues as likely as a sample with 1 or 0 residues.

Average celery sample had 3.7 residues



## How risky is that residue?

- Serving size (grams consumed)
- Body weight (kilograms)
- Residue level (mg/kg of food, or ppm)
- Toxicity of pesticide (acute and chronic Reference Dose)



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## Crop Pesticide Data Pairs (CPDP)

Comparison of the MEAN RESIDUE



**CELERY**  
**CHLOROTHALONIL**

|                      |                              |
|----------------------|------------------------------|
| Organic<br>0.005 ppm | No Market Claim<br>0.397 ppm |
| Ratio<br>79.5        |                              |



**PEACH**  
**PHOSMET**

|                      |                              |
|----------------------|------------------------------|
| Organic<br>0.011 ppm | No Market Claim<br>0.082 ppm |
| Ratio<br>7.45        |                              |



**POTATO**  
**CHLORPROPHAM**

|                      |                             |
|----------------------|-----------------------------|
| Organic<br>0.322 ppm | No Market Claim<br>2.62 ppm |
| Ratio<br>8.16        |                             |

## Chlorpyrifos residues in peaches by country of origin and ranked by residue level, 2002 PDP

| Rank | Country | Market Claim    | Residue Level |
|------|---------|-----------------|---------------|
| 1.   | Chile   | No Market Claim | 0.079         |
| 2.   | Chile   | No Market Claim | 0.078         |
| 3.   | Chile   | No Market Claim | 0.071         |
| 4.   | Chile   | No Market Claim | 0.056         |
| 5.   | Chile   | No Market Claim | 0.049         |
| 6.   | Chile   | No Market Claim | 0.048         |
| 7.   | Chile   | No Market Claim | 0.047         |
| 8.   | Chile   | No Market Claim | 0.046         |
| 9.   | Chile   | No Market Claim | 0.045         |
| 10.  | Chile   | No Market Claim | 0.043         |
| 11.  | Chile   | No Market Claim | 0.042         |
| 12.  | Chile   | No Market Claim | 0.038         |
| 13.  | Chile   | No Market Claim | 0.037         |
| 14.  | U.S.    | No Market Claim | 0.036         |
| 15.  | Chile   | No Market Claim | 0.036         |



94 of top 100 peach residues were from Chilean samples



## ORGANIC PRODUCTION

### What about risks from pesticides allowed in organic production?

- Spurious claims often made by critics of organic – backed by no data
- Organic farmers DO use pesticides, but much less toxic ones and much less often
- Public education is needed about the difference between conventional and organic pest management systems and risks

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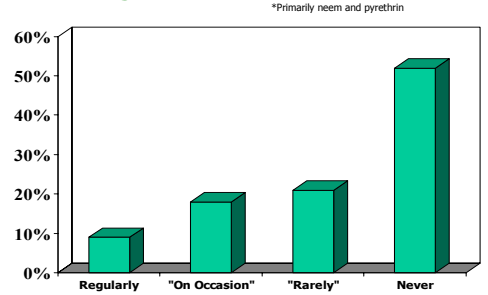


## ORGANIC PRODUCTION

### Natural and biochemical pesticides allowed

- sulfur
- horticultural oils
- copper based fungicides
- *Bacillus thuringiensis (Bt)*
- azadirachtin (neem)
- spinosad
- soaps
- repellants
- botanical insecticides
- pheromones
- natural plant growth regulators
- other microbial pesticides

## Use of botanical\* insecticides used in organic farming



Source: Waltz, E., Final Results of the Third Biennial National Organic Farmers' Survey, Organic Farming Research Foundation, Santa Cruz, CA, 1999

## ORGANIC PRODUCTION

### Residues and risk issues

- Sulfur – widely used in both conventional and organic farming systems with no risk concerns (natural element)
- Copper – same as sulfur
- Pyrethrins – very low rate of application (~0.01 pound per acre). Breaks down very quickly. Near zero risk of residues



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## ORGANIC PRODUCTION – residues and risk issues

- Rotenone – Minimal use. 0.01 pound/acre application rate. Not persistent, near zero dietary risk.
- Sabadilla – only used on citrus at a very low application rate of 0.02 pounds/acre. Near zero risk, partly due to the presence of a peel



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## ORGANIC PRODUCTION – residues and risk issues

- Spinosad – low rate of application. Residue found in ~ 1/3 treated nectarines. Low levels are found (0.006 – 0.029 ppm). Low toxicity level, RfD=0.0268. Spinosad is 268 times less toxic than the high-risk organophosphates and carbamates



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## Key finding in *Pesticide Dietary Exposure SSR*

Extensive and highly sensitive pesticide residue testing carried out by the U.S.D.A. shows that conventionally grown fruits and vegetables are --

- Three to over four times more likely, on average, to contain residues than organically grown produce.
- Eight to 11 times more likely to contain multiple pesticide residues than organically grown produce.
- Contain residues at levels three to 10 times higher, on average, than corresponding residues in organic fruits and vegetables.



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**KEY FINDING**

Heavily contaminated fruits and vegetables frequently consumed by infants and children

- Apples
- Pears
- Peaches
- Nectarines
- Strawberries
- Cherries
- Celery
- Spinach
- Sweet bell peppers



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**Alan Greene, MD, FAAP**

Founder, DrGreene.com  
Author, *First Kicks to First Steps*  
Assistant Clinical Professor  
Stanford University School of Medicine

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**Premature birth: A silent crisis**

Every day 1 in 8 babies born in the U.S. arrives too soon. Premature birth can happen to any woman and be life threatening for her baby

March of Dimes



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**Silent Spring**  
by Rachel Carson  
Boston, Houghton Mifflin Company (2002)



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**Association between Maternal Serum Concentration of the DDT Metabolite DDE and Preterm and Small-for-Gestational Age Babies at Birth**

*The Lancet*  
Volume 358, Number 9276. Pages 110-114.  
July 14, 2001



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## DDT and DDE Exposure in Mothers and Time to Pregnancy in Daughters

*The Lancet*  
 Volume 361, Number 9376  
 Pages 2205-6  
 June 28, 2003



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|                | Sun         | Mon       | Tues      | Weds      | Thurs     | Fri       | Sat       |
|----------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>OCTOBER</b> |             |           |           |           |           | <b>1</b>  | <b>2</b>  |
|                | <b>3</b>    | <b>4</b>  | <b>5</b>  | <b>6</b>  | <b>7</b>  | <b>8</b>  | <b>9</b>  |
|                | <b>10</b>   | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> |
|                | <b>17</b>   | <b>18</b> | <b>19</b> | <b>20</b> | <b>21</b> | <b>22</b> | <b>23</b> |
|                | <b>24</b>   | <b>25</b> | <b>26</b> | <b>27</b> | <b>28</b> | <b>29</b> | <b>30</b> |
|                | <b>2004</b> | <b>31</b> |           |           |           |           |           |
|                |             |           |           |           |           |           |           |

## Detection of Endocrine Disrupting Chemicals in Samples of Second Trimester Human Amniotic Fluid

*Journal of Clinical Endocrinology and Metabolism*  
 Volume 85, Number 8  
 Pages 2954-7  
 August 2000



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## Association of *in Utero* Organophosphate Pesticide Exposure and Fetal Growth and Length of Gestation in an Agricultural Population

*Environmental Health Perspectives*  
 Volume 112, Number 10  
 Page 1116  
 July 2004



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## Prenatal Insecticide Exposures, Birth Weight and Length Among an Urban Minority Cohort

*Environmental Health Perspectives*  
Volume 112, Number 10  
Page 1125  
July 2004



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## Organophosphorus Pesticide Exposure of Urban and Suburban Pre-school Children with Organic and Conventional Diets

*Environmental Health Perspectives*  
Volume 111, Number 3  
Page 377  
March 2003



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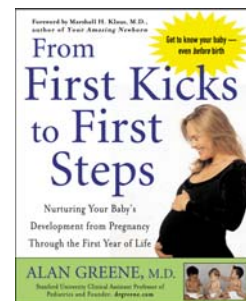
### Many Epidemics

Prematurity    Low-birth weight    ADHD  
Asthma    Autism    Leukemia  
Asperger's syndrome    learning disabilities  
Hypospadias    Falling sperm counts    Testicular cancer  
Breast cancer



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FOR MORE  
INFORMATION



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# DRGREENE.COM



## Kathleen Merrigan, Ph.D.

Assistant Professor  
 Director, Agriculture Food and Environment Program  
 Friedman School of Nutrition Science and Policy  
 Tufts University  
 Boston Massachusetts

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## Impacts of organic farming and processing on antioxidant levels

- Priority area for the organic center
- SSR scheduled for release in late 2004



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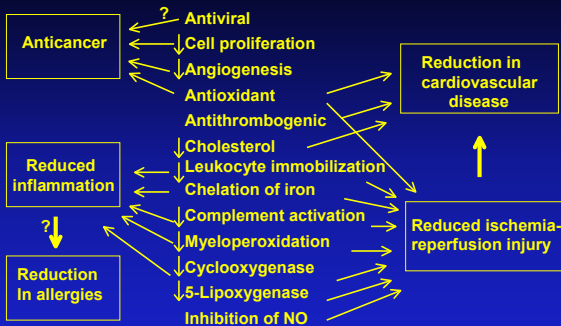
## Three projects initiated in 2004

- World Vegetable Center
  - ✓ lycopene in tomatoes
- WSU Team
  - ✓ strawberry fruit quality
- Tufts University
  - ✓ test methodologies and preliminary assessment of comparative levels

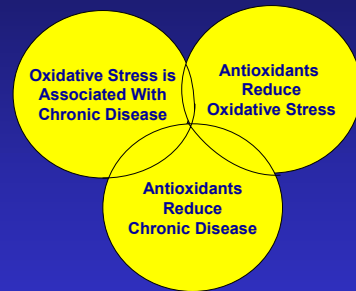


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## Potential Links Between Flavonoid Mechanisms and Disease



Nijveldt et al. Am J Clin Nutr 2001



Chronic Degenerative Diseases  
Associated With Free Radical Damage

|                                     |                                        |
|-------------------------------------|----------------------------------------|
| Adult respiratory distress syndrome | Familial amyotrophic lateral sclerosis |
| Age-related macular degeneration    | lateral sclerosis                      |
| Alcoholism                          | Hemorrhagic shock                      |
| Aluminum neurotoxicity              | Inflammation                           |
| Alzheimer's disease                 | Ischemia                               |
| Cancer                              | Pancreatitis                           |
| Cardiovascular disease              | Parkinson's disease                    |
| Cataracts                           | Porphyria                              |
| Diabetes                            | Rheumatoid arthritis                   |
| Down syndrome                       |                                        |

Institute of Medicine  
Food and Nutrition Board  
Panel on Dietary Antioxidants and Related Compounds

Criteria for defining an antioxidant:

1. The substance is found in human diets.
2. The content of the substance has been measured in foods commonly consumed and can be calculated from available national databases.
3. In humans, the substance decreases the adverse effects of ROS and RNS *in vivo*.

National Academy Press 1998

Antioxidant Defense Network

Endogenous

ENZYMATIC  
catalase (Fe)  
glutathione peroxidase (Se)  
superoxide dismutases (Mn, Cu/Zn)

CELLULAR  
glutathione  
 $\alpha$ -lipoic acid  
ubiquinone  
uric acid

PROTEIN  
ceruloplasmin  
ferritin  
transferrin

Exogenous

ascorbic acid  
tocopherols/tocotrienols  
carotenoids  
phenolic acids  
polyphenolics

Flavonoid Consumption in Several Countries

| Country       | Flavonoids Evaluated | Intake (mg/d) |
|---------------|----------------------|---------------|
| Holland       | 2 flavones           | 23            |
|               | 3 flavonols          |               |
|               | 6 flavan-3-ols       |               |
|               | 4 isoflavones        |               |
|               | total                |               |
| Japan         | 1 flavone            | <1            |
|               | 4 flavonols          | 16            |
|               | 2 isoflavones        | 47            |
|               | total                | 63            |
| United States | 2 flavones           | <1            |
|               | 3 flavonols          | 20-22         |
|               | 4 isoflavones        | <1            |
|               | 2 isoflavones        | 12            |
|               | total                | 20-34         |

Flavonoid Consumption in Several Countries

| Country     | Flavonoids Evaluated | Intake (mg/d) |
|-------------|----------------------|---------------|
| Denmark     | 3 flavanones         | 7-14          |
|             | 1 flavone            | 1-2           |
|             | 2 flavonols          | 15-30         |
|             | total                | 23-46         |
|             | Finland              | 3 flavanones  |
| 2 flavones  |                      | <1            |
| 4 flavonols |                      | 4             |
| total       |                      | 24            |

Dragstead et al. *Eur J Can Prevention* 1997, Knekt et al. *Am J Clin Nutr* 2002, Hertog et al. *Nutr Cancer* 1993, Arts et al. *Eur J Clin Nutr* 2001, Boker et al. *J Nutr* 2002, Arai et al. *J Nutr* 2000, Sampson et al. *J Am Diet Assoc* 2002, de Kluin et al. *J Nutr* 2001, Wu et al. *Carcinogenesis* 2002





