

CADMIUM

toxics risk reduction

cadmium and thallium
in food plants



Pacific Northwest Pollution Prevention Resource Center
practical solutions for economic and environmental vitality

• So...



since sitting is
the new
smoking...





toxicity and chronic disease

- eighty-five to ninety-seven percent of cancer is caused by environmental factors—air, water, food
- heavy metals and persistent organic pollutants are the known key toxics that contribute to not only cancer, but virtually all chronic diseases
- agricultural soil and the plants grown in it are both depleted of nutrients and contaminated with toxins, processed food...
- you are what you eat (and what you don't eat)...

cadmium findings, last year

- Cd used in a number of industries; the largest use is in nickel cadmium batteries (currently about a 51% recovery rate for recycling in the US), coal combustion and transport remain sources of cadmium contamination
- Cd found in NW air, soil, water, sediment, fish, shellfish, and fertilizer
- the half life of Cd in the body is 10 to 40 years and our body burden rises over time, **a daily intake of 12.5 to 25 µg Cd** may cause or contribute to adverse effects—kidney dysfunction, osteoporosis & fractures, neurological damage and diseases, diabetes, **cancer**, and mortality
- the primary pathways of human exposure are inhalation (smoking and localized contamination) and ingestion (food and water)
- **for most people, food is their primary exposure**

so this is P2—why focus on food?

- *Pollution Prevention Act of 1990*, “source reduction” is any practice which (i) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or **otherwise released into the environment** prior to recycling, treatment, or disposal; and (ii) **reduces the hazards to public health and the environment associated with the release.**
- *EPA Definition of Pollution Prevention Memorandum* indicates P2 approaches in the agricultural sector include: **reducing** the use of water **and chemical inputs**
- food, what we eat and what we don't eat, is a major factor in health today
- the WHO identified Cd as a major public health concern
- the major source of exposure to cadmium is food

why is Cd in food?

- Europe has established a link between fertilizer and the levels of cadmium observed in food
- EU adopted a fertilizer limit of 20 mg Cd/kg P₂O₅, it was immediately challenged by some countries as too high to meet human health risk objectives
- fertilizer limits in the US, where they do exist, are probably not sufficient to protect human health
 - CA = 180 mg Cd/kg P₂O₅ (9 times the EU limit)
 - OR = 338 mg Cd/kg P₂O₅ (17 times the EU limit)
 - WA = 889 mg Cd/kg P₂O₅ (44 times the EU limit)
- plants vary widely in their ability to take up and accumulate Cd from soil (hyper-accumulators, 1:1, 1:10, lesser uptake)

which led us to...

- further evaluation of body burden data
- looking at food contamination—the latest Market Basket studies from FDA (100% of spinach—raw, frozen, creamed, baby food... showed cadmium)
- looking at fertilizers, compost, and other soil products registered in Washington and Oregon (highly variable)
- verifying food as a significant source of Cd exposure in the Pacific Northwest, and of course, thallium popped up as a food plant uptake concern as well
- comparing levels of Cd in conventional vs organically grown produce, looking at soil levels vs plant levels

reference doses for perspective

- EPA oral reference dose (1989 for Cd, 2009 for Tl):
 - water = 5×10^{-4} $\mu\text{g Cd}$ per kg-day
(for a 50 kg human, 25 $\mu\text{g Cd}$ per day)
 - food = 1×10^{-3} $\mu\text{g Cd}$ per kg-day
(for a 50 kg human, 50 $\mu\text{g Cd}$ per day)
 - oral = 3×10^{-3} $\mu\text{g Tl}$ per kg-day
(for a 50 kg human, 150 $\mu\text{g Tl}$ per day)
- thousands of recent biomedical articles on the adverse effects of cadmium in humans and show a decline in the lowest observed effects levels
- EU estimates a **total daily intake** of 12.5 to 20 $\mu\text{g Cd}$ per day can cause onset of adverse effects

analytical results sorted by produce type 1

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
mixed greens	0.43	ND	0.039	43	< 3.9	organic	New Seasons	USA	Organic Girl
spinach	0.47	ND	0.046	47	< 4.7	conventional	Kress IGA	USA	
spinach	0.27	ND	0.045	27	< 4.5	conventional	Pike St Market	unknown	
spinach	0.22	ND	0.040	22	< 4.0	organic	Whole Foods	USA--CA	
spinach	0.20	ND	0.038	20	< 3.8	organic	New Seasons	USA & Mexico	EarthBound Farms
spinach, frozen	0.12	ND	0.050	12	< 5.0	organic	Super 1 WW	USA--OR	Natural Directions
spinach	0.088	ND	0.048	8.8	< 4.8	organic	New Seasons	USA	Organic Girl
spinach	0.088	ND	0.037	8.8	< 4.8	organic	Safeway	unknown	
spinach	0.087	ND	0.043	8.7	< 4.3	conventional	Fred Meyer	USA--NW	
spinach	ND	ND	0.053	< 5.3	< 5.3	organic	Pike St Market	USA	

analytical results sorted by produce type 2

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
lettuce	0.34	ND	0.038	34	< 3.8	organic	Pike St Market	unknown	
lettuce	0.22	ND	0.041	22	< 4.1	organic	New Seasons	USA & Mexico	
lettuce	0.12	ND	0.042	12	< 4.2	organic	Pike St Market	unknown	
lettuce	0.12	ND	0.044	12	< 4.4	conventional	Kress IGA	unknown	
lettuce	0.087	ND	0.046	8.7	< 4.6	no fertilizer	home garden	USA--OR	
lettuce	0.044	0.039	0.039	4.4	3.9	organic fertilizer	home garden	USA--OR	
lettuce	0.042	ND	0.041	4.2	< 4.1	conventional	Safeway	unknown	
lettuce	ND	ND	0.099	< 9.9	< 9.9	?	home garden	USA--WA	
lettuce	ND	ND	0.046	< 4.6	< 4.6	organic	Target	USA--CA	
lettuce	ND	ND	0.044	< 4.4	< 4.4	conventional	Fred Meyer	USA--NW	
lettuce	ND	ND	0.043	< 4.3	< 4.3	organic	New Seasons	USA	

analytical results sorted by produce type 3

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
kale	0.080	0.039	0.038	8.0	3.8	organic	Pike St Market	unknown	
kale	0.071	ND	0.048	22	< 4.1	organic	New Seasons	USA & Mexico	
kale	0.057	ND	0.050	12	< 4.2	organic	Pike St Market	unknown	
kale	0.045	0.074	0.044	12	< 4.4	conventional	Kress IGA	unknown	
kale original	0.043	0.052	0.037	8.7	< 4.6	no fertilizer	home garden	USA--OR	
kale	ND	ND	0.098	4.4	3.9	organic fertilizer	home garden	USA--OR	
kale, tuscan	ND	0.071	0.047	4.2	< 4.1	conventional	Safeway	unknown	
kale	ND	ND	0.047	< 9.9	< 9.9	?	home garden	USA--WA	
kale	ND	ND	0.045	< 4.6	< 4.6	organic	Target	USA--CA	
kale duplicate	ND	0.050	0.042	< 4.4	< 4.4	conventional	Fred Meyer	USA--NW	
kale	ND	ND	0.042	< 4.3	< 4.3	organic	New Seasons	USA	

analytical results sorted by produce type 4

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
chard	0.22	ND	0.096	22	< 9.6	compost	home garden	USA--WA	
chard, red swiss	0.073	ND	0.049	7.3	< 4.9	organic	Safeway	USA NW	
cilantro, duplicate	0.20	ND	0.049	20	< 4.9	conventional	Andy's	USA--NW	
cilantro, original	0.19	ND	0.048	19	< 4.8	conventional	Andy's	USA--NW	
cilantro	0.17	ND	0.049	17	< 4.9	no fertilizer	home garden	USA--OR	
cilantro	ND	ND	0.046	< 4.6	< 4.6	organic	Safeway	USA--NW	
basil	ND	ND	0.049	< 4.9	< 4.9	no fertilizer	home garden	USA--OR	
peas, frozen	ND	ND	0.047	< 4.7	< 4.7	conventional	Super 1 WW	USA	Flav-R-Pac
peas	ND	ND	0.045	< 4.5	< 4.5	conventional	Andy's	USA	Green Giant
pea plants	ND	ND	0.050	< 5.0	< 5.0	no fertilizer	home garden	USA--OR	

analytical results sorted by produce type 5

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
green cabbage	ND	ND	0.050	< 5.0	< 5.0	organic	CSA	USA--WA	Growing WA CSA
green cabbage	ND	ND	0.048	< 4.8	< 4.8	conventional	Super 1 WW	unknown	
cauliflower	ND	ND	0.048	< 4.8	< 4.8	conventional	Andy's	USA--CA	Bonita Packing Co
cauliflower leaves	ND	ND	0.049	< 4.9	< 4.9	conventional	Andy's	USA--CA	Bonita Packing Co
broccoli	ND	ND	0.049	< 4.9	< 4.9	organic	Safeway	unknown	
broccoli, frozen	ND	ND	0.049	< 4.9	< 4.9	organic	Super 1 WW	Mexico	Woodstock
broccoli	ND	ND	0.049	< 4.9	< 4.9	organic	PCC	USA - CA, OR, WA	
radishes	ND	ND	0.043	< 4.3	< 4.3	no fertilizer	home garden	USA--OR	
radish leaves	0.094		0.039	9.4		no fertilizer	home garden	USA--OR	

analytical results sorted by produce type 6

product	cadmium mg/kg (ppm)	thallium mg/kg (ppm)	LOQ mg/kg (ppm)	cadmium µg/100g serving	thallium µg/100g serving	farm type	retail	country of origin	brand
carrots	0.24	ND	0.049	24	< 4.9	organic	Safeway	USA	
carrots	ND	ND	0.047	< 4.7	< 4.7	organic	Safeway	unknown	Earthbound Farms
carrot tops	0.058	ND	0.049	5.8	< 4.9	organic	Safeway	unknown	Earthbound Farms
carrots	ND	ND	0.049	< 4.9	< 4.9	no fertilizer	home garden	USA--OR	
carrot tops	ND	ND	0.049	< 4.9	< 4.9	no fertilizer	home garden	USA--OR	
beets	ND	ND	0.049	< 4.8	< 4.8	organic	PCC	USA--WA	
beet greens	ND	ND	0.049	< 4.7	< 4.7	organic	PCC	USA--WA	
potatoes, red	ND	ND	0.044	< 4.4	< 4.4	conventional	Andy's	unknown	
potatoes, russett	ND	ND	0.047	< 4.7	< 4.7	conventional	Andy's	unknown	
white mushroom	ND	ND	0.047	< 4.7	< 4.7	conventional	Andy's	unknown	

by the numbers

should this affect the way we eat?

- we know leafy green and cruciferous vegetables are very important to good health
- we know they are contaminated both with cadmium and to a lesser extent thallium—and without testing there is no way to choose the least contaminated
- so...

information should lead to outcomes

- remove cadmium at the source—the phosphate rock mines or the initial phosphorous processing
- testing and cleaning up soils, certifying soil replacement products
- testing produce could also be done and is somewhat easier than testing soils but because of high variability from field to field, product to product, and fertilizer batch to batch, it is expensive; probably most effective through the National Organic Standards Board
- direct education of people...

THANK YOU!