

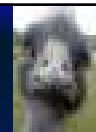
“Bioactive Food Component Databases: Opportunities and Challenges”

**Subtitle: My Thoughts and Dreams about
Composition Databases??**

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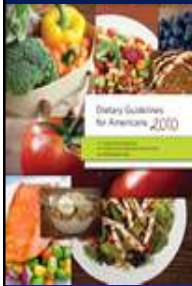


Fundamental Food Composition Tenets



Knowledge

- Will assist in developing a better understanding of how foods impact human nutrition & overall health
- **Will form the basis by which dietary adequacy is assessed; both under- and over-nutrition.**
- Is key to establishing dietary intake goals .
- **Gained from traditional, underutilized and wild sources is essential to evaluate food security and**
 - relevant to both the health and agriculture sectors
 - will only be realized when more data are available on composition and intake.





The problem is the multitude of bioactive components!



Over 2500 Constituents

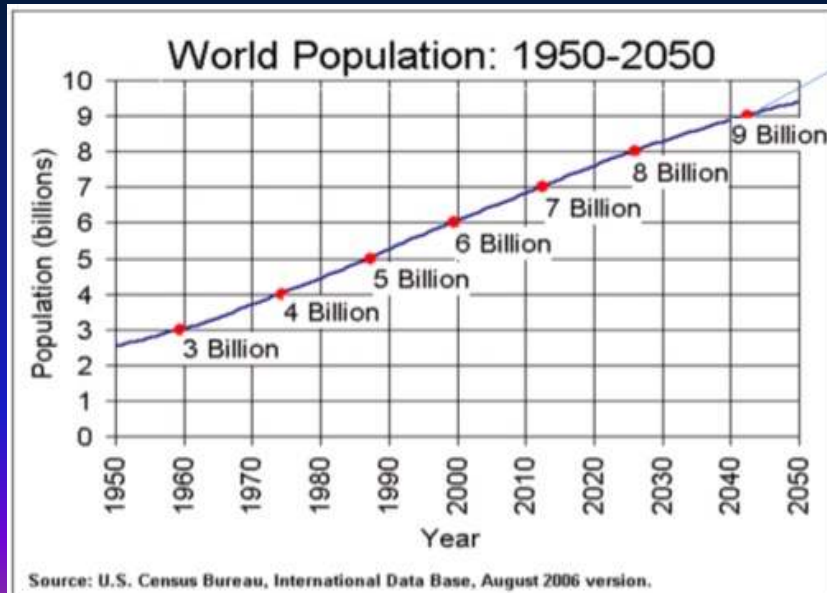
Important Interactions



Many appear to influence health but without adequate exposure information their **relevance** is not truly known !!

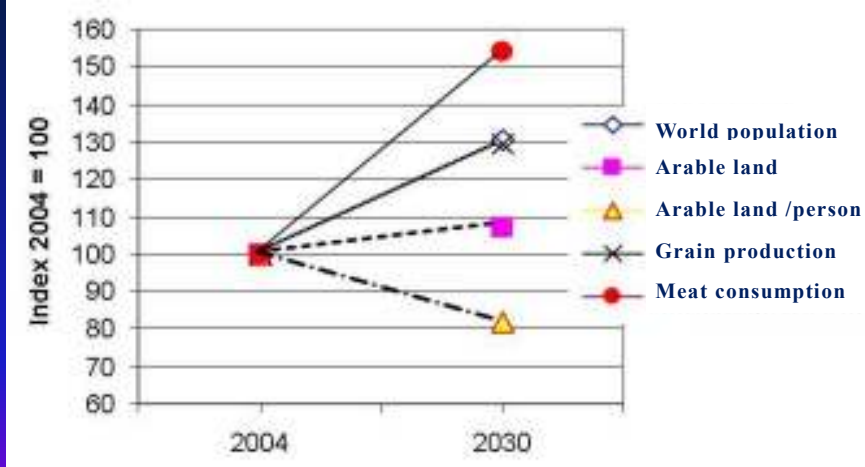


Demand for Food/Components Will Continue to Expand



Will Food Production Be Able to Keep Up With Population Growth

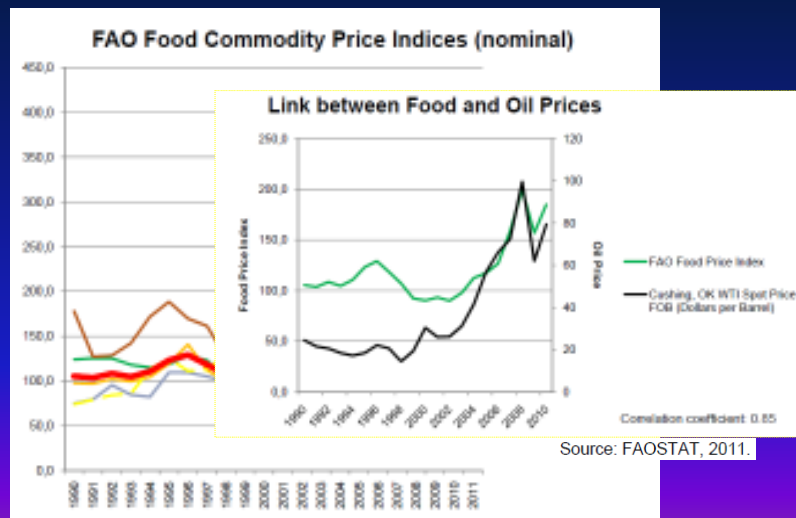
Change in food system



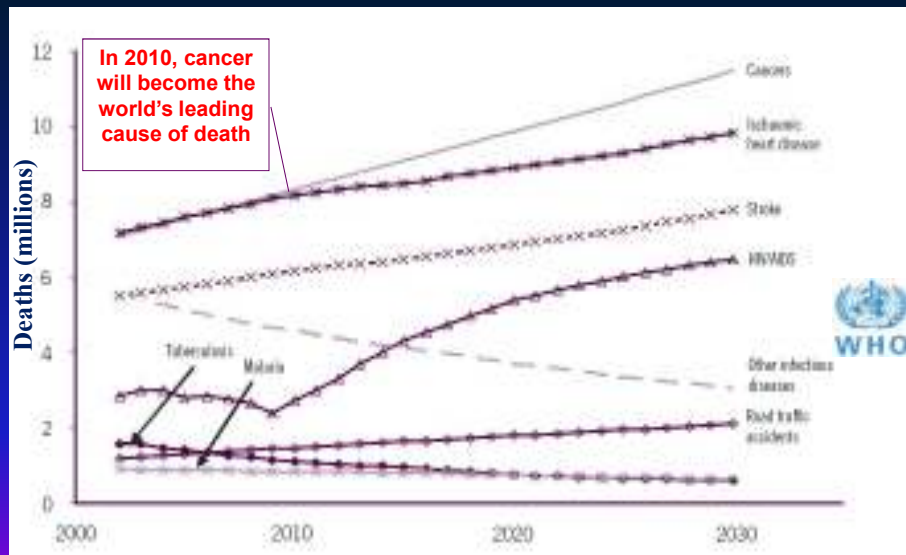
Institut für Technikfolgenabschätzung und Systemanalyse (ITAS), 2008

Food Prices Will Likely Continue to be Volatile and Result in Challenges for food production & Consumers

changes in economics



Risk of Disease Will Likely Influence Demand



Can we prevent this by making available appropriate food/supplement choices??

Recent Findings Are Concerning!!

About 65% of premature deaths (heart disease, cancer, diabetes, obesity, etc.) relate to inappropriate dietary intakes. Unless current health trends are reversed the five common, non-infectious diseases -- cancer, diabetes, heart disease, lung disease and mental health problems -- will cost the world \$47 trillion in treatment costs and lost wages over the next 20 years.

World Economic Forum and Harvard University 2011

Dietary Strategies are important to reducing these premature deaths!! UN General Assembly 2011

Food and Health

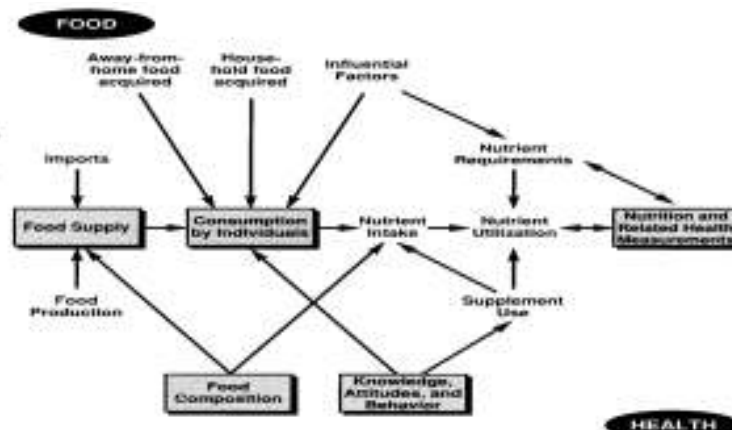
Positive health requires a knowledge of man's (**human**) primary constitution (**genetics**) and of the powers of various foods, both those natural to them and those resulting from human skill (**processed food**). But eating alone is not enough for health. There must also be exercise, of which the effects must likewise be known. The combination of these two things makes regimen, when proper attention is given to the season of the year, the changes of the winds, the age of the individual and the situation of his (**her/his**) home. **If there is any deficiency in food or exercise the body will fall sick.**

Hippocrates

"The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition."

Thomas Edison

USDA and HHS Have Embraced this Concept



*Adapted from: U.S. Department of Health and Human Services and U.S. Department of Agriculture, Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program, 1992.

About \$1.5 Billion Spent on Nutrition Research Last Year.

Unfortunately Knowledge About Composition of Foods and Supplements Remains Incomplete and Limited due to:



- **Composition information often limited to small number of assessments**



- **Composition of foods is changing. Low fat meats, elimination of Trans-fat, fish varieties, folate fortification, etc.**

- **Hundreds of new food items introduced into the marketplace each year.**



Can or Should Food Composition Databases be All Inclusive??



Maybe, but
Likely
Cost
Prohibitive!!



Therefore, need to prioritize food components to be examined in existing and new composition databases!!

Ideally Use Multiple Sources of Data

Ongoing Analytical Determinations
(USDA, FDA, CDC, EPA, Industry)



Data from
Scientific
Literature

(Reliability??)

Label
Information

Limited Scope

Where to Focus??

**Most frequently consumed foods/supplements
or available sources (traditional, underutilized
and wild)?**

Across the world there are approximately 2,000 plant species that are cultivated by humans for food, few have been adequately characterized.

Unknown how many of these offer opportunities for improving the nutritional status of individuals and promoting health? Knowledge about underutilized or wild foods may expand opportunities to promote health!

Multiple Federal Entities Contribute monies to assist USDA create National Nutrient Composition Database

While several hundred foods characterized for basic components few (ca. 140) of the 25,000 bioactive constituents evaluated.



How Much Time to Maintaining the Store vs Creating New Databases Especially in Challenging Budget Times??

- **Macro-constituents are not constant (energy, water, fat, protein, carbohydrates, dietary fiber) and thus need updates?**

- **Macronutrient -vitamins and minerals vary in their national interest due to emerging science, i.e. Sodium- (not just salt please) ,Vitamin D, Vitamin K, Iodine**

Phytochemicals/Zoochemicals/fungochemicals/bacterochemicals – Lots of different type molecules with varying biological effects, must prioritize!

- **Contaminants- Not always given attention in the same foods that supply many bioactive food components.**

We Recognize Differences in Food Composition Occur and Have Biological Relevance

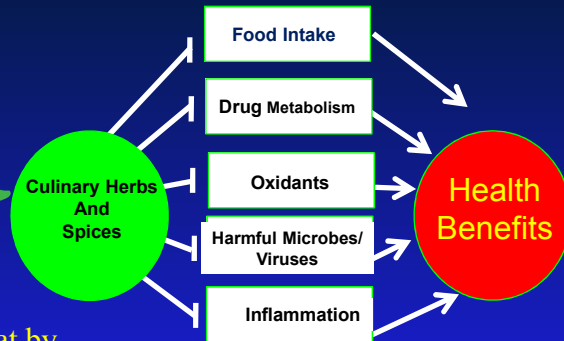
| | Protein g | Fiber g | Iron mg | β -carotene μ g |
|--------------|--------------|------------|------------|------------------------------|
| Rice | 5.6-14.6 | | 0.7-6.4 | |
| Potato | 1.4-2.9 | 1.2-2.3 | 0.3-2.7 | 1.0-7.7 |
| Sweet Potato | 1.3-2.1 | 0.7-3.9 | 0.6-14 | 100-23100 |
| Banana | | | 0.1-1.6 | <1-8500 |

| | RDI Vit A % Bananas |
|----------|------------------------|
| USA | 0.7 |
| Lacatan | 9.3 |
| Utin Iap | 219.8 |

Content Across Same Type Food Can Be Significant (The Mushroom Example)

| | White | Crimini | Portabella | Oyster | Shitake |
|----------------------|------------|-------------|--------------|------------|-------------|
| Fat | 0.3 | 0.1 | 0 | 0.3 | 0.18 |
| Carbohydrates | 2.7 | 3.6 | 3.3 | 5.1 | 12.1 |
| Protein grams | 2.6 | 2.1 | 1.8 | 2.8 | 1.3 |
| Selenium mcg | 7.8 | 21.8 | 15.6 | 2.2 | 20.8 |
| Vitamin D IU | 6 | 3 | 8-375 | 24 | 26 |

Where Do Spices Fit: Fascinating Flavor Fact



Archeologists estimate that by 50,000 B.C. primitive man had discovered parts of certain aromatic plants made food taste better!

Today Few Surveys Evaluate Herbs and Spices Due to Inadequate Database Information

Solution 1. Include More information in Databases

Includes New Food Items

Include Species/Strain- Maybe Add Scientific name

Provide Normal Range of Concentrations and distribution

Must Recognize Why There Are Changes In Foods in the Market Place: "New Paradigm- It's all about ME"



"What consumers really appear to hunger for are products that fit their unique needs, wants and desires"



"They want products that talk just to them, work just for them and appeal just to them on an emotional level..."



Deeply linked with the emerging "me" trend is the consumer desire to stand apart from the crowd and express one's individuality.

Twenty or thirty years ago, it was all about fitting in. Today it's about standing out from the crowd.

Datamonitor



Ready to Eat Foods Are Increasingly Available

**Some only for a Short Time!
How Best to Monitor**



Likely Need to Develop Partnerships With Food Industry So That Just In Time Food Composition Information is Available



Collaborations are Possible: Database for the Proanthocyanidin

This database was created through a collaborative effort between the Nutrient Data Laboratory and Food Composition Laboratory, USDA-ARS; The Arkansas Children's Nutrition Center, USDA-ARS; Mars, Inc.; and Ocean Spray Cranberries, Inc.

The database contains values for 205 food items

Monomers

Dimers

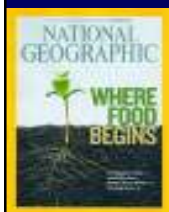
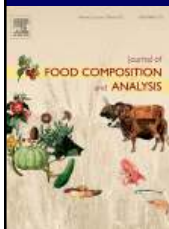
Trimers

4-6 mers (tetramers, pentamers and hexamers)

7-10 mers (heptamers, octamers, nonamers and decamers)

Polymers (DP>10)

Expand Composition Databases by Use of Peer-Reviewed Publications.



Data must be assessed with respect to: food description; processing description; component identification; representativeness of sample; sample handling; analytical methodology and analytical performance including appropriate reference standards.



Recently value documentation used to develop Czech Food Composition Database. Machackova et al. (2010) Eur J Clin Nutr. 64 Suppl 3:S64-7.

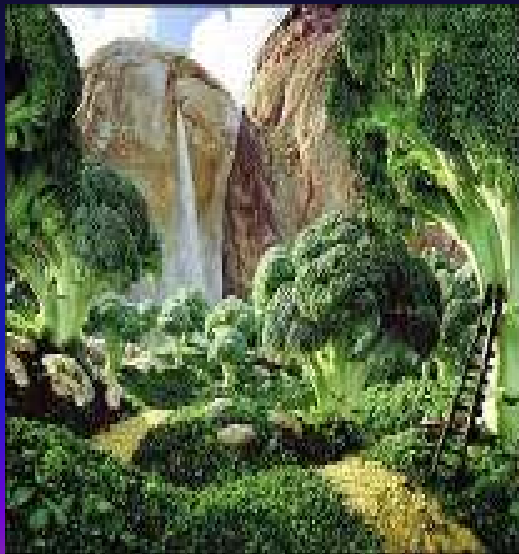
Solution 2:

Expand the use of literature searches and foster existing and new partnerships (industry/government/academic) to develop/expand new nutrient composition databases

Develop new analytical technologies

Create reference standards

Compounds in Foods With Potential Health Benefits Require new Databases (Cruciferous Vegetable Example)



Family Cruciferae (Brassicaceae)

◆ >350 Foods: e.g. Cabbage, Broccoli, Cauliflower, Kale, Watercress, Arugula, Radish, Wasabi .

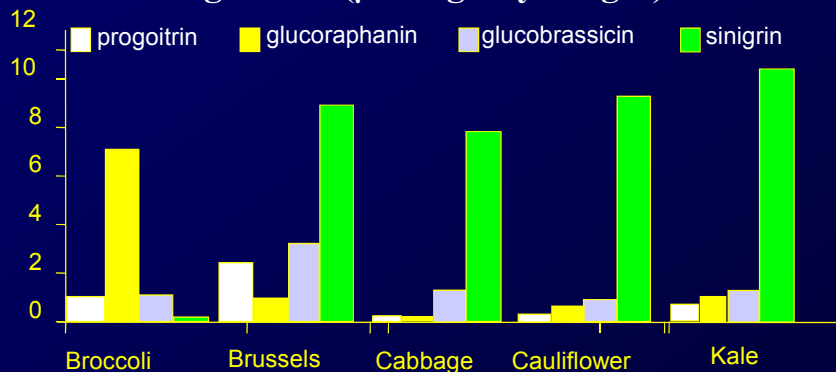
Many appear to have health benefits.

Maybe attributed to:

Glucosinolates, Quercetin, Kaemferol, Vitamin C, E, and K, β -carotene, Lutein, Zeaxanthine, selenium

Bioactive Constituents Vary Across Same Type Foods

Variation in Glucosinolate Among Cruciferous vegetables ($\mu\text{mol/g DryWeight}$)



Kushad et al, (1999) J Agric Food Chem. 47:1541



Not Simple to Evaluate Spices/Herbs Since Often Complex Chemical Composition

Pepper: Active Ingredient(s):

-black & white pepper- piperine

-red pepper and paprika- capsaicin

Oregano: Active Ingredient(s): thymol, carvacrol

Cumin: carvone, 1,8-cineole, alpha-pinene, alpha-terpinene, beta carotene, beta-pinene, beta-sitosterol, caffeic acid, campesterol, carvacrol, carvaol, geranial, kaempferol, limonene, linalool, p-coumaric acid, petrocelinic acid, phytosterols, quercitin, stigmasterol, tannin

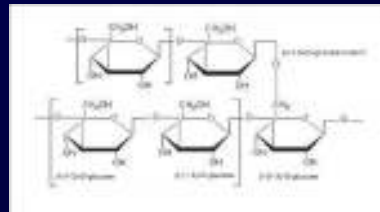
Scientists found women consuming a third of an ounce of fresh mushrooms every day were 64% less likely to develop a tumor.



The consumption of 15g mushrooms/day may decrease breast cancer risk in postmenopausal women.



Multiple compounds may contribute but b-glucans seem important



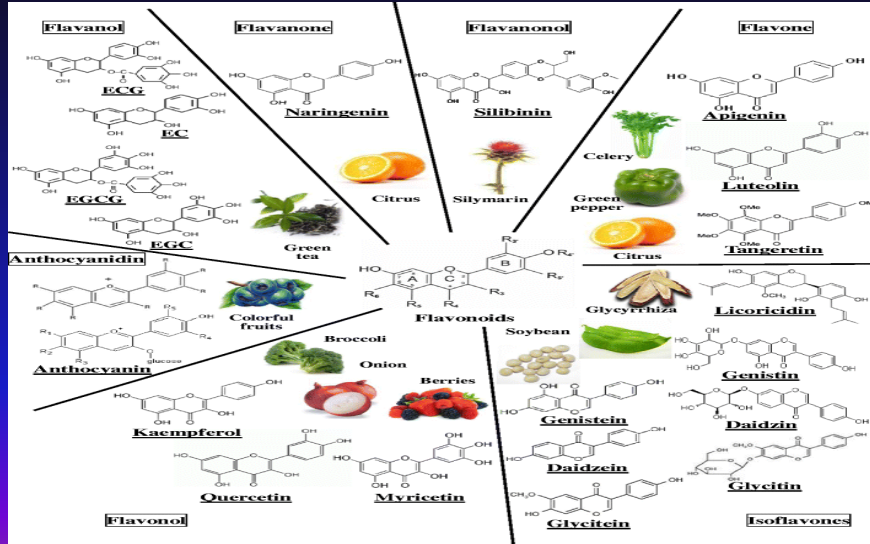
- Zhang, et al. (2009) Int J Cancer. 124(6):1404-8.
- Hong et. al (2008) Int J Cancer. 122(4):919-23.

Common β -glucans and their sources and structures

| Source | Structure |
|---|--|
| Shitake Mushroom <i>Lentinus</i> | 1,3 1,6 branched |
| Maitake Mushroom <i>Grifola frondosa</i> | 1,3 1,6 branched with xylose and mannose |
| <i>S. cerevisiae</i> (yeast) | 1,3 and small numbers of 1,6 branches and 1,6 linked |
| Barley, oat, wheat, rye, rice | 1,3 1,4 mixed linkage, unbranched |

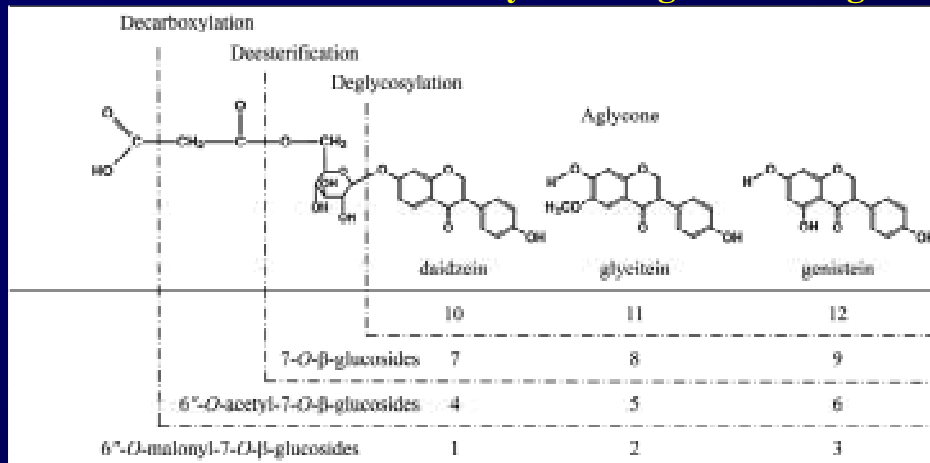
Murphy et al (2010) Curr Opin Clin Nutr Metab Care. 13(6):656-61.

Preliminary research indicates that flavonoids may modify allergies, viruses and carcinogens, and thus may be biological "response modifiers".



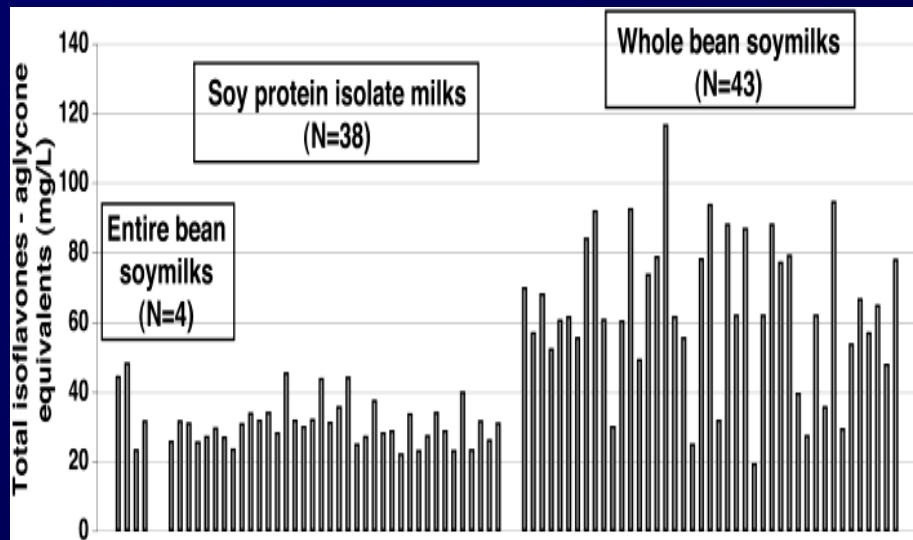
Wang and Yen (2012). *Cancer Metastasis Rev* Feb 8. [

Specific Compounds Can Exist In Several Forms: Which Can Be Influenced by Growing /Processing



Yuan et al. (2009) *J. Agric. Food Chem.*, 57 (19), pp 9002–9010

Growing Conditions/Processing May Influence Amounts Being Consumed



Setchell and Cole (2003) *J Agric Food Chem* 51(14):4146-55.

There are Over 4000 Known Flavonoids How Complete Should We Be??

Current USDA database contains values for 500 food items for five subclasses of flavonoids:

FLAVONOLS: Quercetin, Kaempferol, Myricetin, Isorhamnetin

FLAVONES: Luteolin, Apigenin

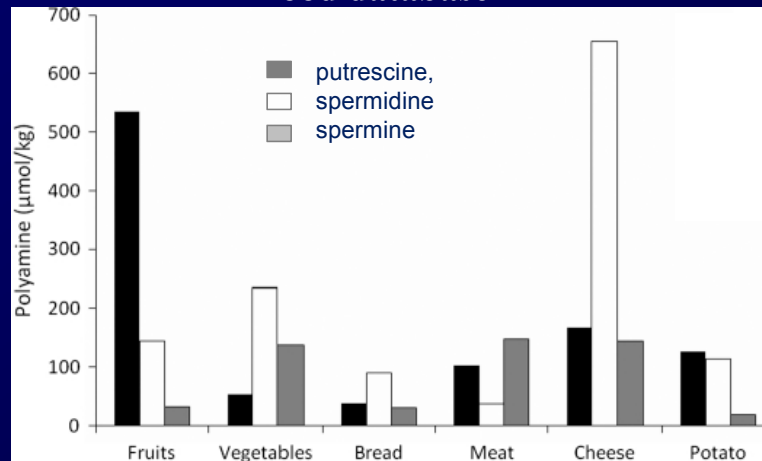
FLAVANONES: Hesperetin, Naringenin, Eriodictyol

FLAVAN-3-OLS: (+)-Catechin, (+)-Gallocatechin, (-)-Epicatechin, (-)-Epigallocatechin, (-)-Epicatechin 3-gallate, (-)-Epigallocatechin 3-gallate, Theaflavin, Theaflavin 3-gallate, Theaflavin 3'-gallate, Theaflavin 3,3' digallate, Thearubigins

ANTHOCYANIDINS: Cyanidin, Delphinidin, Malvidin, Pelargonidin, Peonidin, Petunidin

Some Compounds May Promote Growth

Polyamines in foods: development of a Swedish food database

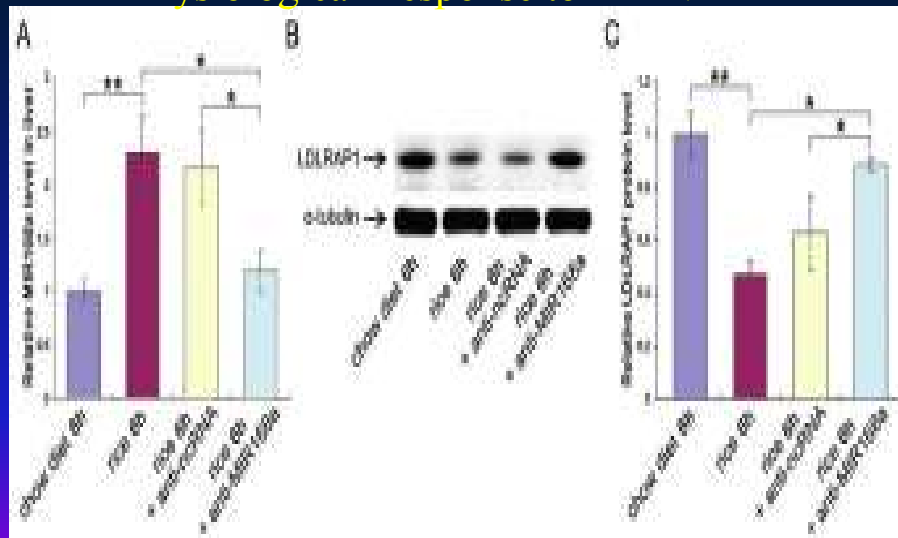


Exposure to these polyamines may promote growth

Atiya et al (2011) Food Nutr Res. Jan 14;55.

What Are Important Dietary Components?

Physiological Response to miRNA



Zhang et al. (2011) Cell Research 1-20.

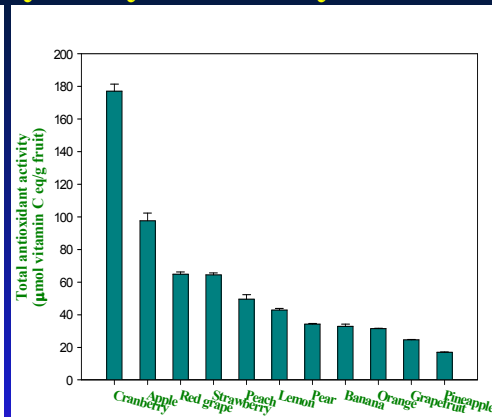
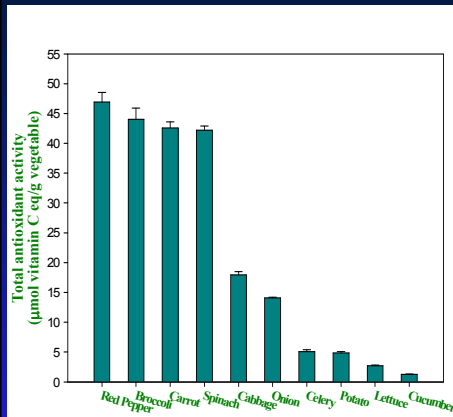
Cooking Can Influence the Content of Bioactives

(mg/100g fresh wt)

| Food | Processing | Total glucosinolate (mg/100 g fresh wt.) |
|------------------|------------|---|
| Broccoli | Raw | 61.1 |
| | Cooked | 37.2 |
| Brussels sprouts | Raw | 247.0 |
| | Cooked | 148.0 |
| Cabbage | Raw | 108.9 |
| | Cooked | 78.6 |
| Cauliflower | Raw | 62.0 |
| | Cooked | 42.0 |

Sones et al. (1984) J Sci Food Agric 35: 712-9

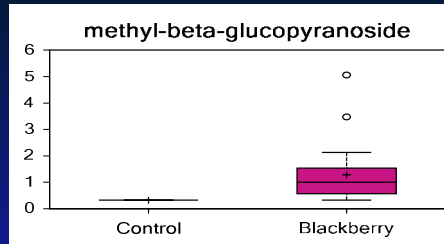
Not All Fruits and Vegetables are Equal! Antioxidant Activity Vary Markedly!!



Sun et al., J. Agri. Food Chem. 50: 7449-7454, 2002

**Should Other Relative Efficacy Profiles Be Generated?
Interest in antimicrobial, anti-inflammatory, immunoregulatory, etc.**

Food Derived Metabolites



- Although little is known about the compound methyl-beta-glucopyranoside, this biochemical was notably absent in all control plasma samples and present in all samples from blackberry-fed individuals, indicating a potentially novel biomarker of blackberry diet compliance. This compound may reflect increased concentrations of cyanidin-3-glucoside and/or its metabolism in blackberry-fed patients.

Nicastro et al. (2012) Experimental Biology Meetings

Solution 3: Need More Information about Individual Foods/Constituents, their Variability and Efficacy

Especially

Isothiocyanates and allyl sulfur

Flavanoids, β -glucans, polyamines, mRNA

Influence of Processing

Relative Efficacy

Markers of Exposure

Dietary Toxins

Who Should Evaluate

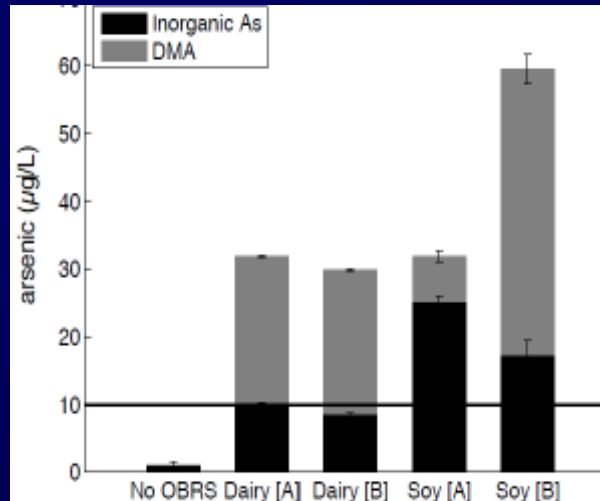
- Metabolic systems exist to detoxify harmful substances, including pesticides, heavy metals and some potentially harmful compounds.
- Inappropriate dietary intakes of essential and non-essential bioactive food components can influence the response to these compounds

Acrylamide Databases

Acrylamide, a probable human carcinogen, has been detected in various heat-treated foods including French fries and potato crisps. Positive associations have been found between dietary acrylamide intake, using a food frequency questionnaire and acrylamide database, and cancer risk in some epidemiological studies.

Recent acrylamide database generated in Netherlands [Konnings et al. (2010) Eur J Clin Nutr 64(5):534-4.] documents its appropriateness for epidemiological studies to evaluate intake and ultimately cancer risk

Rice a Major Source of Inorganic Arsenic for Many Sub-populations. Impact on Infant Formulas



Arsenic coming from organic brown rice syrup

Equivalent to Drinking 2 L Tap water by adult

Jackson (2012) Environ Health Perspect Feb 16.

Solution 4:

Enhance Working Relationships with others with commitment to understanding environmental factors and health

Using existing stored residual food/supplement samples to evaluate controversial agents in the food supply

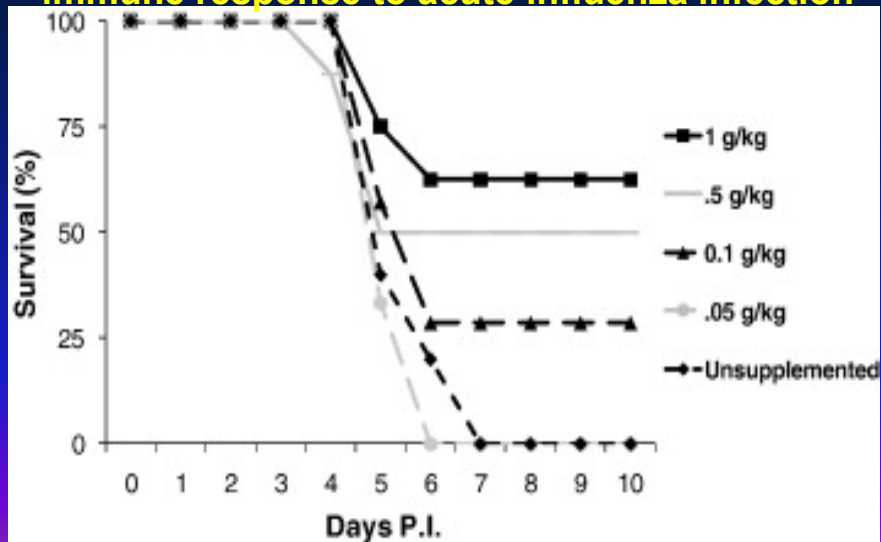
Consumers Choices: Is one better than the other??



Approximately 68% US population consuming supplements of varying composition. Should not avoid supplement usage and therefore their contributions to total exposures must be determined



Other Stressors May Determine Needs: Mushroom Active Hexose Correlated Compound improves the immune response to acute influenza infection



Nogusa et al. (2009) Nutr Res. 29(2):139-43.

Unverified Health Benefits: But Still Exposures That Need to Be Considered!

Nitric Oxide



Alcohol Relief
Methylcobalamin,
other B vitamins.



Cognition/Health



Solution 4: Expand Information about Bioactives Provides by Dietary Supplements

Must Verify Content of Supplement

Special analytical technologies likely needed

Create new reference standards as appropriate needed again possibly through special partnerships between industry/government/academia.

While I have raise lots of Concerns:
There Is Light At the End of the Tunnel!



Any
Questions/
Comments??

