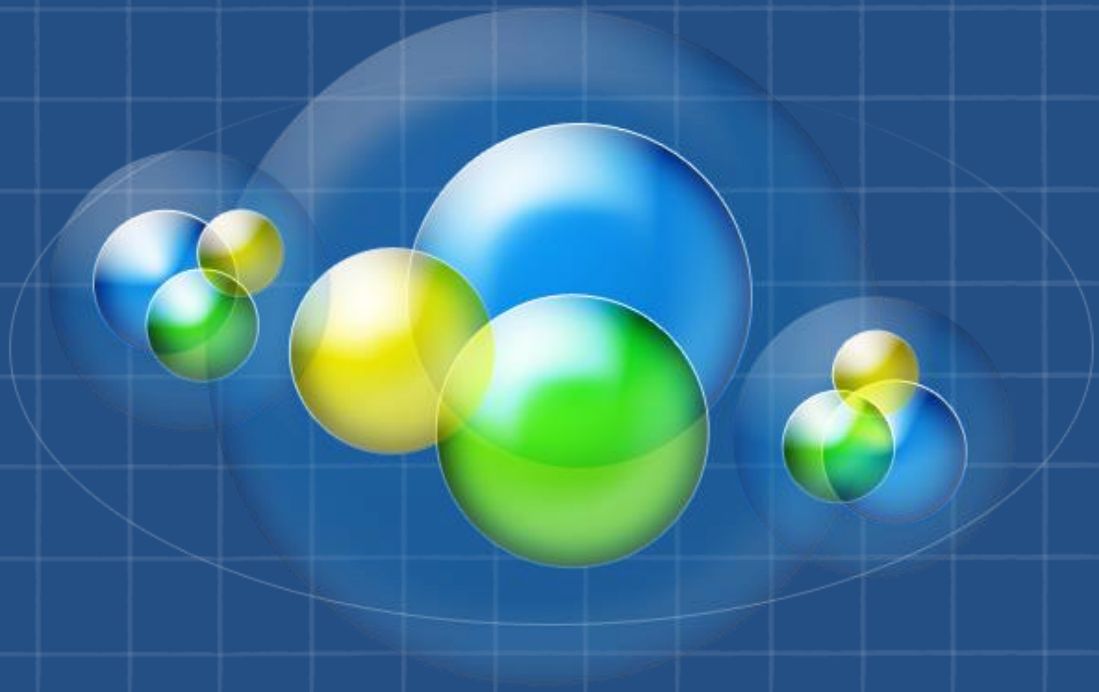


How Risky is Risky?

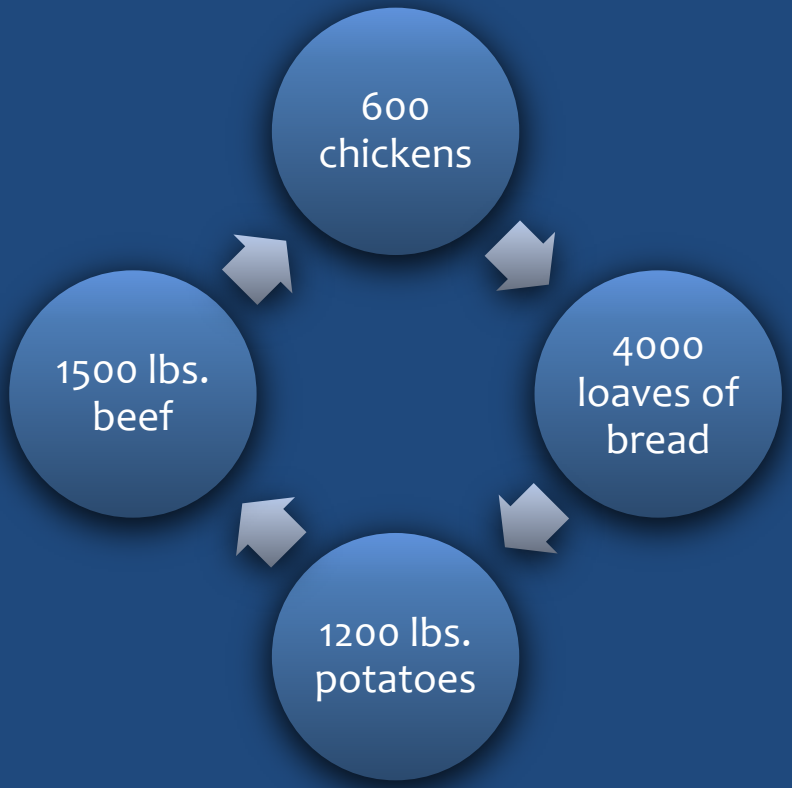
The Use of Risk Assessment in Establishing Safety

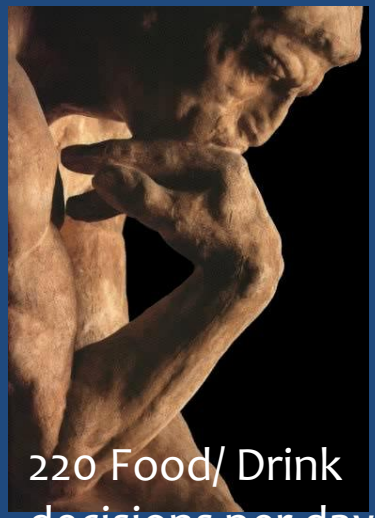
Julie Jones, St. Catherine's University, Professor Emerita, St. Paul, MN

What This Talk Will Cover

- Definition of risk and risk assessment as applied to food
  - How differences in risk perception color the analysis
- Dioxin
- Nitrate – from villain to essential nutrient?
- Heat-produced toxins in food

Lifetime ~ 80000 meals



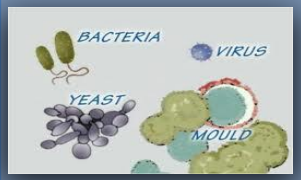


220 Food/ Drink decisions per day

- No wonder we all think of ourselves as food experts!
- I eat, therefore I know.

Krebs, JR Philos Trans R Soc Lond B Biol Sci. 2005; 360(1458): 1133–1144.

Top Food Safety Stories 2012



27 microbial - Salmonella, Listeria, E. coli, Yersinia

2 involved foreign objects – metal, plastic

1 cow with BSE in California

1 involved chemical contamination

- Pickles in Poland – used road salt
- Not food grade - a mixture of Na, K, Mg, Ca chlorides

Other selling of expired goods, bribery, pink slime etc

N=38

Premature Deaths/ Year

Poor diet related **>>500 000**

- 33% ⇧risk for cancer and coronary heart disease

Texting while driving **6000**

Food-borne illness **3000**

- (> 1,600 – known agent)
- 48 million people (1 in 6) get sick 128,000 are hospitalized
  - Poultry 19% of the deaths
  - Fruits-Nuts, Fungi vegetables, Leafy vegetables, Root vegetables, Sprout vegetables, Vine-Stalk vegetables - 46% illnesses

http://www.oddee.com/item_98002.aspx

Premature Deaths/ Year

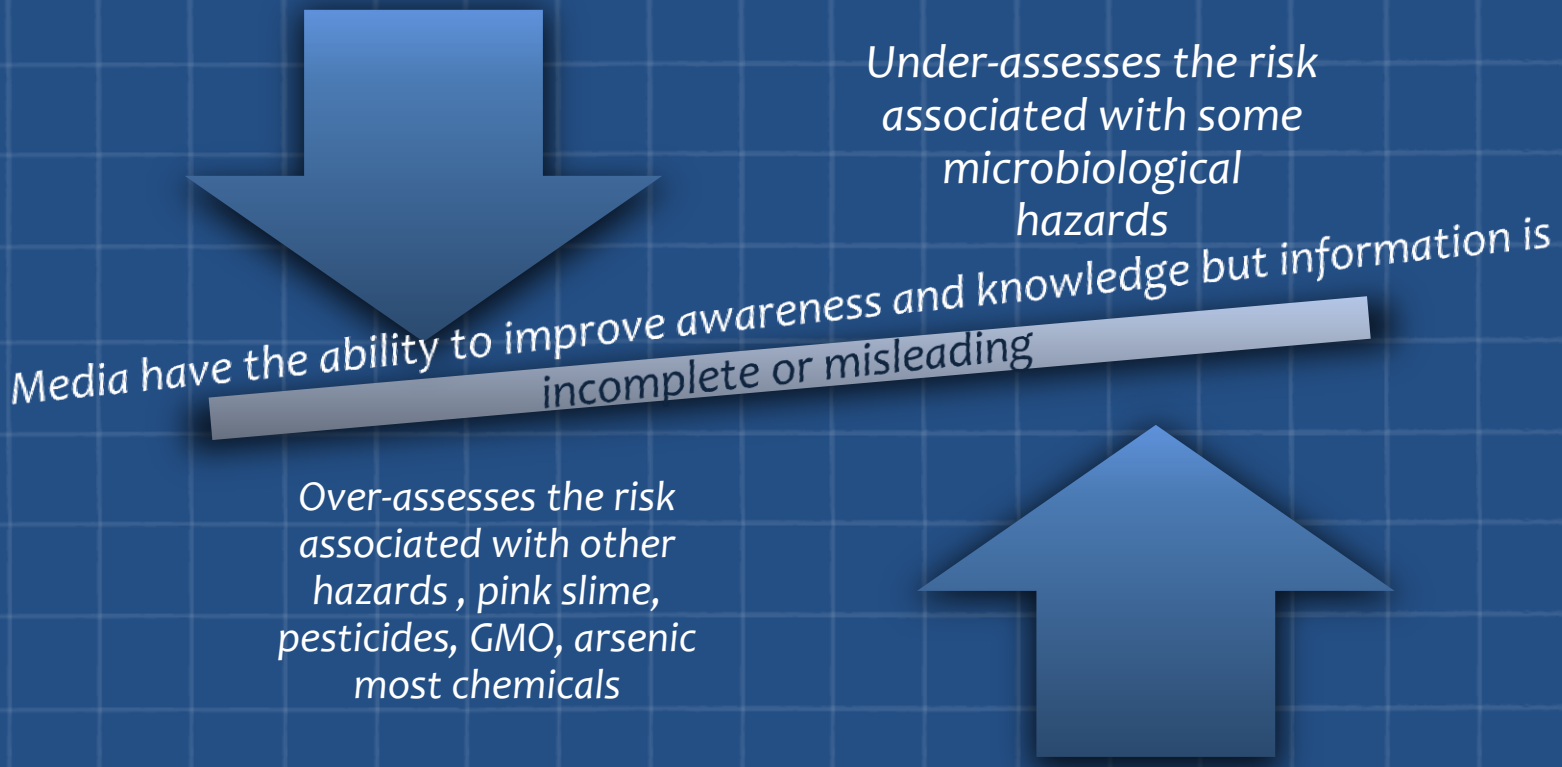
Getting in or out of bed	100
Choking children <10yr	77
Accidental pesticide poisoning	27
Vending machines toppling	13

Pesticides and chemicals in food ?

GMOs or veterinary drugs in food ?

http://www.oddee.com/item_98002.aspx

Food Risk & Public Perception



De Boer, M et al. J Fd Safety 2005; 25: 241-65 DOI: 10.1111/j.1745-4565.2005.00020.x

Risk - WHO

Risk Assessment

is using scientific information to describe the likelihood and magnitude of harm attributed to a specific hazard

Toxicology and Epidemiology

Risk Management
includes
all activities undertaken to control a hazard

Risk Communication

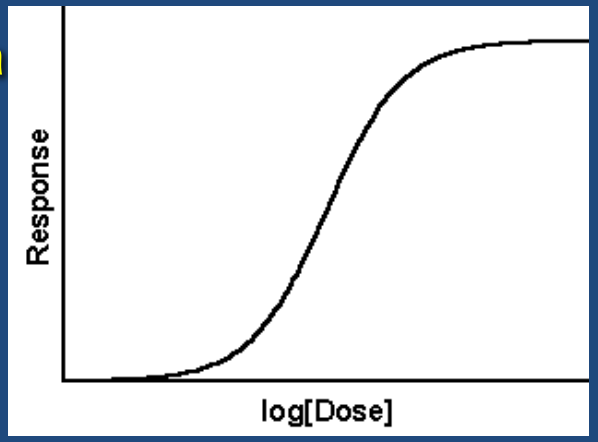
is the exchange of information and opinions about a hazard among concerned parties.

Risk Analysis

is accomplished through the efforts of separate but integrated assessment, management and communication teams

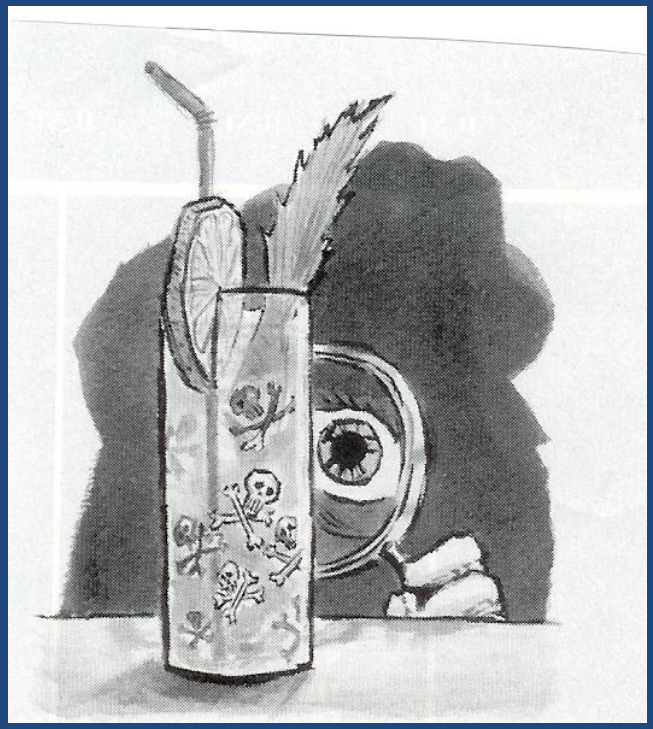
Risk Assessment of Food Chemicals

- The process of quantifying the probability of a harmful effect to individuals or populations from chemical X added directly or inadvertently or leached into food.
  - No formal process is used for naturally occurring substances in food.
- The real issue is determining whether a hazard might occur from chronic consumption of a low level of X.
  - Toxicology and epidemiology



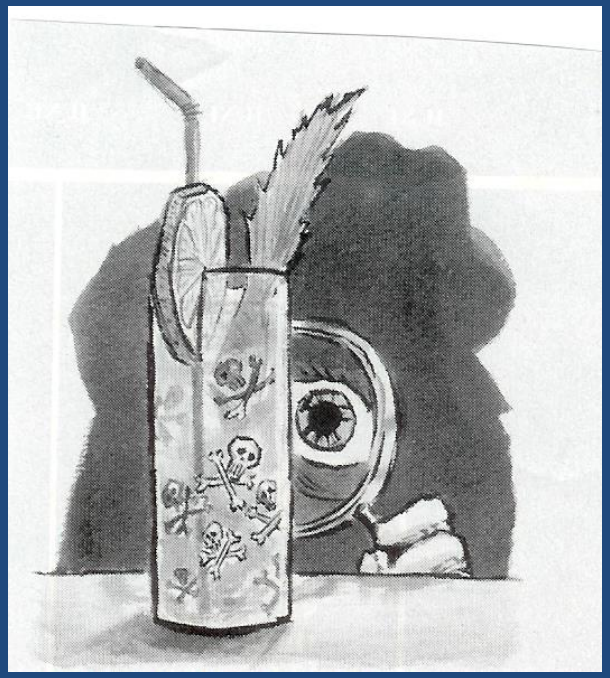
Risk Assessment of Food Chemicals

- Requires knowledge of special susceptibility by vulnerable groups
  - If the susceptible group is small, how should their needs be addressed
- Special treatment of carcinogenic, mutagenic, genotoxic
  - 1973 FDA -Concentrations not allowed if it increases risk greater than 1 in a million lifetime

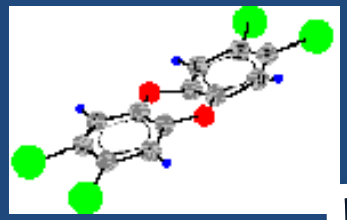


Determining Acceptable Level of Risk

- "Acceptable" if 1 in 10,000 lifetime risk
  - Provide some protection for exposure to multiple chemicals
- 1 in 1,000,000 in a lifetime –1973 FDA - carcinogenic, mutagenic
  - Still a number of adverse events in a large population
- Lower or zero-risk may not be technologically feasible or may be prohibitively expensive
  - ➔possible only with the suppression of the risk-causing chemical ➔ which may introduce an unintended consequence
  - The problem with chasing zero



Case Studies



Dioxin Recommendations

- EPA reassessment in 2010 <0.7 picograms (<1 trillionth g/kg bw/d)
- WHO 2.3 picograms/kg bw/d
- EU 1- 4 picograms /kg bw/d
- Ave. US intake 0.5–3 picograms/kg bw/d

"The Most Toxic Chemicals Known to Science"
*www.ejnet.org/**dioxin**/*

Dueling Experts - Dioxin

1. **High levels dioxins in farmed salmon** -especially Scottish salmon
   Group of scientists recommended eating no more than 2-3 sv/yr (2004 report)

2. **FDA FSA WHO -no cause concern for people eating salmon 1X/wk**
   - Levels of current average consumption far below level of concern
     - Dioxins do not bond DNA directly ➔ bind to a receptor site
     - Likely a level at which there is no effect and allow normal cell funct
     - People need the health benefit of oily fishes

3. **EPA - dioxins can cause cancer at any dose and this is a linear dose relationship**
   - ➔Adherence to the EPA position - difficult to eat a balanced diet because of the ubiquity of dioxins in food.

Hites et al. 2004

Toxicologists and Dioxin

Evenly mixed	• Even split -use of animal studies to estimate human toxicity
Data Compared	• Pacific wild salmon compared with farmed Atlantic salmon • No difference in levels when fish were drawn from the same ocean
Political, ideological and personal issues/ agendas	• American scientists stirring up trouble for Scottish industry • Environmental concerns mixed with food safety

Dioxin Recommendations

- **If people try to meet the EPA 2010 level of <0.7 picograms (<1 trillionth g/kg bw/d)**
- ***Any potential unintended consequences?***
- Food Industry Dioxin Working Group - International Dairy Foods Association, the American Frozen Food Institute, and the National Chicken Council wrote *" EPA's proposal…* ***nearly every American – particularly young children – could easily exceed the daily RfD*** *after consuming a single meal or heavy snack…."*
- *What should the risk assessment be?*

Heat-Induced Toxins

Claes Oldenburg 1960s
Whitney Musuem NYC

Heat - Induced Toxins

- High heat and deep frying
- Formation of potentially carcinogenic agents
  - Polycyclic aromatic hydrocarbons
  - Aldehydes
  - Acrolein
  - Heterocyclic amines
  - Acrylamide

Heat-Induced Toxins

Prostate Cancer Attributing the Cause

- Prostate cancer case 1545 control 1492
- Tertiles of intake - deep fried food
  - Low <1 wk vs high > 21 x/wk (3X/d)
- OR > 1.3 French fries, Fried chicken, Fried fish, Doughnuts
- No assoc. snack chips (OR = 1.08)
- ??? Regular intake of deep fried foods

and/or other aspects of the Western lifestyle?

Stott-Miller et al, 17 JAN 2013 Prostate DOI: 10.1002/pros.22643

From pizza and burgers to scorpions and jelly beans, you can deep fry almost anything. - Chicago Tribune

Fried Food - Risk

- Fried food - No association all cause mortality
  - HR 0.93 ns
- No difference olive oil vs sunflower oil - Myocardial Infarction (MI)
- No association non-fatal MI - case-control Costa Rica
- INTERHEART - positive association with acute MI
  - case-control study conducted in > 50 countries
- Associated with obesity (Italian and Spanish studies)

Spanish EPIC 40,757 adults aged 29-69
Guallar-Castillón et al. BMJ 2012;344:e363

Fat and Fried Food - Risk

- **Reused oils -higher prevalence of arterial hypertension**
  - Industrial deep fryer at 190 °C. 40 hours (8 hours a day) ➔ unsaturated aldehydes
    - **Linked to some cancers & neurodegenerative diseases such as Alzheimer's and Parkinson's.**
- Random inspections of 5,995 food items such as deep-fried chicken, sausages, fried chips, meatballs and pork snacks
  - ~ 10 % had **polar compounds** >>limit of 25 %of the used oil

Bangkok FDA
March 20, 2013

Guillén M, Uriarte P (2012). Food Chemistry 131 , 915–926.

Heterocyclic Amines (HCA)

- 20 HCAs formed during cooking
  - mutagens & risk factor for human cancer
- Well done meats, pan drippings, and crispy meat surfaces
  - HCA well-done meat - 3.5 X > than medium-rare
    - Well done assoc. with cancer risk, rare no assoc.
  - Amts and species highly dependent on conditions
  - Chicken breast
    - Charcoaled 112 ng/g > Pan fried 8- 27 ng/g > Roasted 4 ng/g
  - Fried bacon 17.59ng/g fried pork 13.9ng/g

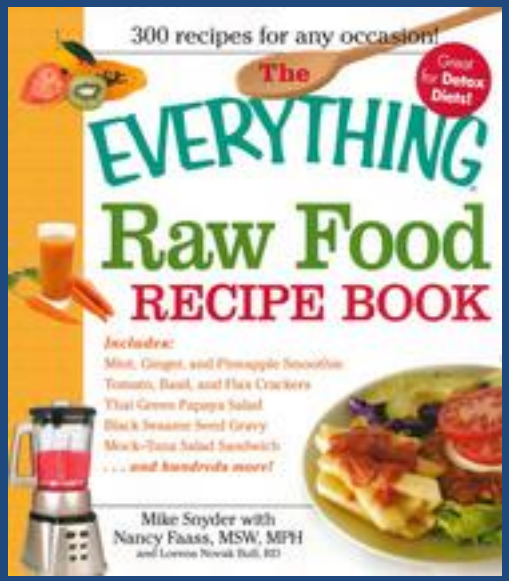
Puangsombat K et al. Meat Sci. 2012;90:739-46; Figg eg al Cancer Biol Ther. 2012;13:1141-2: Liao, GZ Meat Sci. 2010;85:149-54

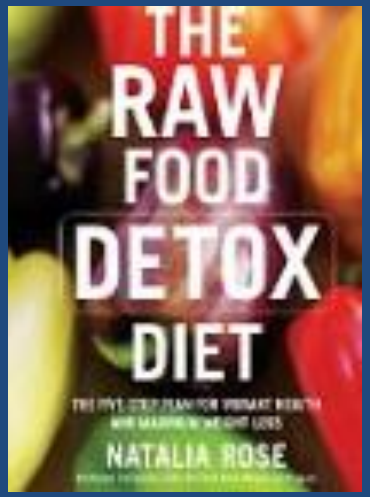
Heterocyclic Amines (HCA)

- No effect of meat, meat cooking preferences, meat mutagens or heme iron on lung cancer risk in the prostate, lung, colorectal and ovarian cancer screening trial
  - N=99,579 ages 55-74
- NIH-AARP Diet and Health Study
  - Afr-Amer subset - red meat at high T °
    - increased risk of prostate cancer
  - Not white meats or processed meats

Tasevska N,Int J Cancer. 2011;128:402-11; Major JM et al Cancer Causes Control. 2011;22:1691-8.

Alternates to Cooking





Raw Thanksgiving Turkey???

Nitrates

From Carcinogen to NO

Nitrate to Nitrosamine

- Nitrosamines - a most potent group of carcinogens
- Formed during frying, smoking and food preserved with pickling salt and in the acidic conditions of the stomach
  - Reaction of secondary or tertiary amino compounds and nitrite or nitrogen oxides
- Beers, cheeses, sausages, smoked and pickled foods
  - N-nitrosodimethylamine 0.049 - 16.47 mg/kg
  - Smoked sausage – highest
- 300 compounds fed to animals ~ 90% are carcinogenic

Ciemniak A. Rocz Panstw Zakl Hig. 2006;57:341-6

Nitrates and Cancer Risk

- NIH-AARP Diet and Health Study N=490,194
  - 50–71 years of age
- Nitrate and nitrite ingestion were NOT associated with stomach cancer risk
  - But Low intake of vitamin C + high nitrate increased⇧ risk
    nitrate HR = 1.40 nitrite HR = 1.52
  - Processed meat nitrite and nitrate were NOT associated with risk among those with either high or low vitamin C intake

Ward, M. Epidemiology. 2011; 22: S107-S108

Nitrates, NO and Reduced CVD

- Nitrate-nitrite-NO pathway
  - Endogenous /dietary nitrate → nitrite → nitric oxide (NO) in various tissues
    - May reduce inflammation and be antibacterial
- Impaired bioavailability of NO
  - Critical regulator of vascular homeostasis → a major problem in cardiovascular disease (CVD)
    - In the absence of co-administration of a carcinogenic nitrosamine precursor, no increase cancer
  - *"Nitrite (as well as nitrate-rich diet for long-term applications) may hold promise as therapeutic agent in vascular dysfunction and ischemic injury, as well as an effective compound able to promote angiogenesis."*

Bryan NS et al. Food Chem Toxicol. 2012;50:3646-65; Machha A, Schechter AN. Eur J Nutr. 2011;50:293-303; Castiglione et al Antioxid Redox Signal. 2012;17:684-716

Nitrate in Vegetables

- ↑consumption of vegetables ↓risk CVD
  - Vegetables ~80-85% of daily exogenous nitrate intake →possible contributor to CVD health benefits of vegetables

Machha A, Schechter AN. Nutr Rev. 2012 ;70:367-72;
Bryan NS et al. Food Chem Toxicol. 2012;50:3646-65.

Nitrate Intake

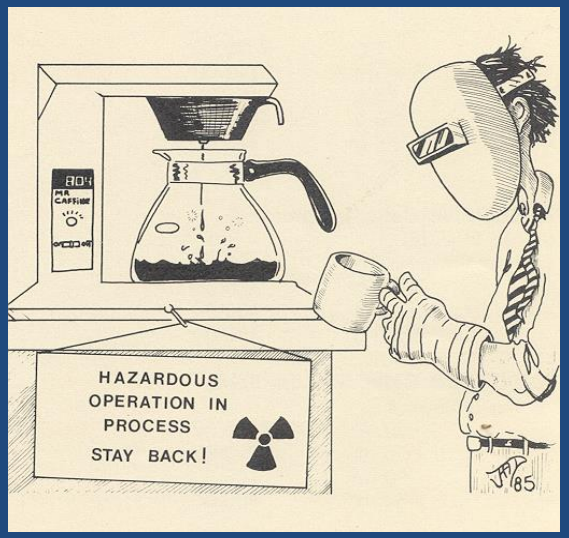
- Mean usual intake — 1.38 mg /kg bw/ d
  38% ADI
- Highest consumers (97.5%) — 2.76 mg /kg bw/ d
  76% ADI
  - Vegetables (especially lettuce) — 50%
  - Water/ foods prepared with water — 20%
  - Meat — 6%
  - Cheese — 0.2%
  - Highest amount from human saliva, beer etc

Belgian Food Consumption Survey - 3245 respondents, age> 15

Temme EH Food Addit Contam Part A Chem Anal Control Expo Risk Assess. 2011 ;28:1193-204.

What Should the Risk Assessment Be for Nitrate in Meats

Acrylamide



"Bread, buns and coffee can be dangerous as they might contain the chemical compound acrylamide, which the Technical University of Denmark's (DTU) National Food Institute now links to cancer." EU food safety authorities have been asked to investigate. March 26, 2013

http://www.euractiv.com/health/
research-coffee-breakfast-produc-news

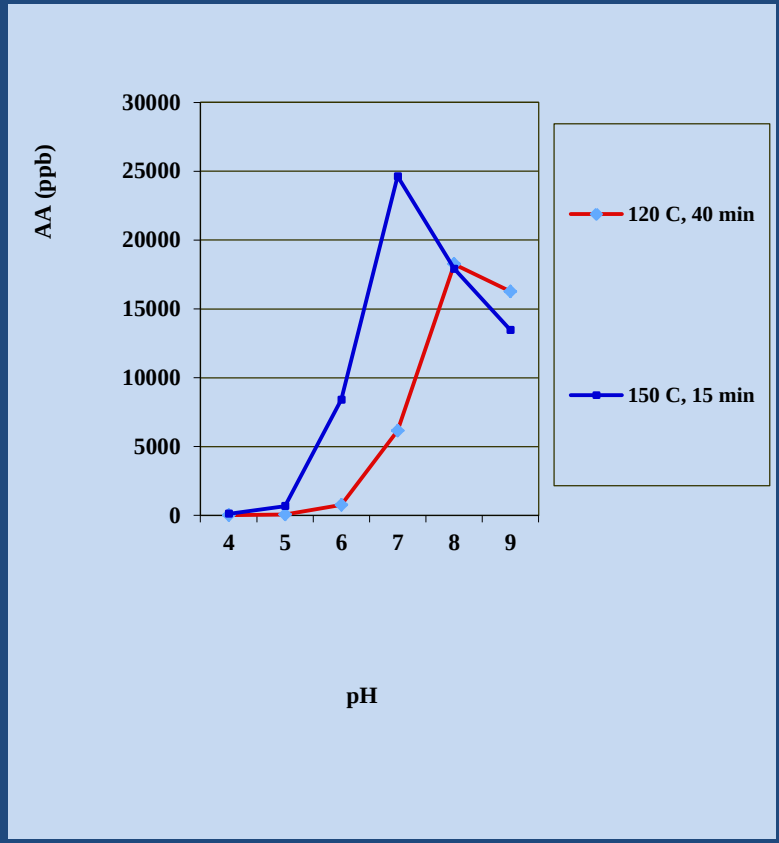
Bread and Acrylamide

- 192 Breads/ Rolls - 5 and 1987 µg/kg ave. 30 µg/kg
  - Rye
  - White
  - Wholegrain

- Fine bakery wares (puff pastry , laminated doughs, fried bread, etc.) ave. 145 µg/kg Range 4 -3324 µg/kg
- UK Food Standards Agency (UK) advises not to alter diets or cooking methods 2010

Bread and Acrylamide

- Asparagine
  - High in bran
  - Wholegrain flour > white flour
  - ↑ sourdough
- Acrylamide - not different
  - White
  - Wholewheat
  - Rye breads (n=48)
  - Sourdough - Acrylamide formation ↓ pH less favorable



Coffee and Acrylamide

Sweden - 1/3 of the acrylamide from coffee

- Reduces
  - Parkinson's
  - Type 2 Diabetes
  - Alzheimer's
  - Various cancers
- Increases
  - Problem solving ability
  - Blood lipids
  - Blood pressure
  - Insomnia

Noyce et al. Ann Neurol. 2012;72:893-901; Mulay et al. Curr Diabetes Rev. 2012;8:162-8: Butt and Sultan. Crit Rev Food Sci Nutr. 2011;51:363-73.

Of Coffee, Cookies and Disease

EPIC-Potsdam 23 531 participants

- **Lower chronic disease risk**
  - **Whole-grain bread**
  - **Raw vegetables**
  - **Coffee**
  - **Cakes and cookies**
- **Higher risk**
  - **Low-fat dairy**
  - **Butter**
  - **Red meat**
  - **Sauce**

von Ruesten A et al. 6 February 2013; doi: 10.1038/ejcn.2013.7

- *Overall, a healthy diet was characterized by a high consumption of whole-grain bread, raw vegetables and a low consumption of red meat and possibly butter, which is generally in line with previous findings. The paradoxical findings concerning the potential health benefit of coffee as well as cakes and cookies are interesting….*

Risk Assessment is Difficult

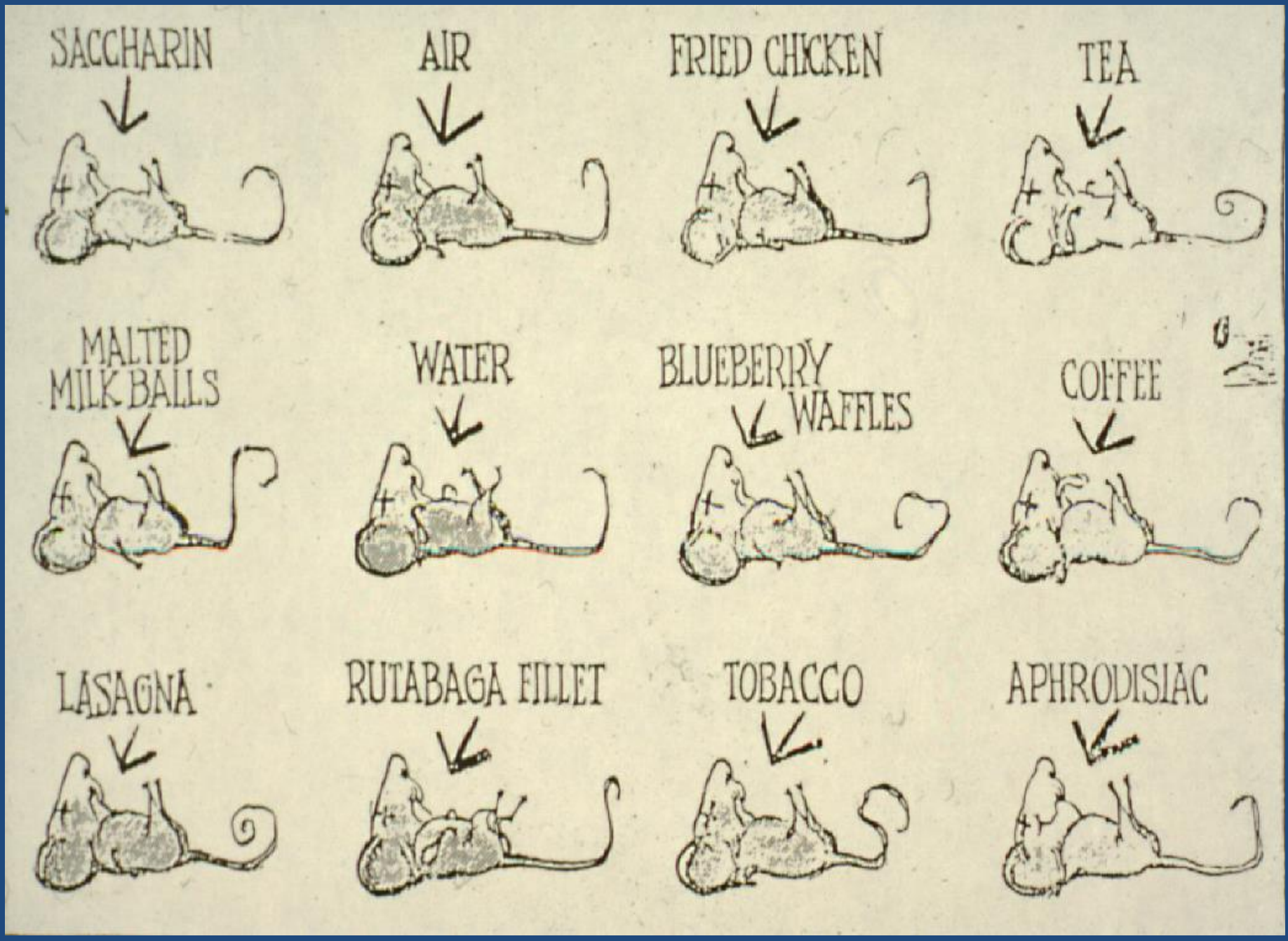
"Never assume the obvious is true."

William Safire

American author, columnist and presidential speechwriter


EAT


DIE


SACCHARIN
AIR
FRIED CHICKEN
TEA
MALTED MILK BALLS
WATER
BLUEBERRY WAFFLES
COFFEE
LASAGNA
RUTABAGA FILLET
TOBACCO
APHRODISIAC