Does Processing of Foods Impact Cancer Risk?

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ILLINOIS

Acknowledgements

Sue Monckton –will be missed! - nomination

Marla Todd - nomination

Tanner Selection Committee

Fred Tanner

- UIUC faculty member 1923-1956
- IFT President 1945-46
- Influential in the establishment of the Department of Food Science in Urbana/Champaign in 1948

Reference Article

Can Food Processing Enhance Cancer Protection?

Erdman, Jeffery, Hendrickx, Cross and Lampe.

Nutrition Today (in press, 2014)

Based upon symposium at the 2013 American Institute for Cancer Research Meeting

Outline of Presentation

- Food processing – a perspective
- Cancer incidence – role of diet
- Ying and Yang of processing foods
- Illinois studies on prostate cancer
- Recommendations/ Conclusions

What is Food Processing?

It is the transformation of raw ingredients into food, or of food into other forms

Source: Wikipedia

Historical Look

"The growth of towns and cities involved larger needs (for food) and new difficulties in storage and transportation ….. gradually transformed food production from an occupation to a business"

Prescott and Proctor. Food Technology. 1935

Prehistoric Food Processing Procedures

- Fermentation
- Sun Drying
- Preservation with salt
- Various types of heating and smoking

Modern Industrial Food Processing

- Fermentation (with and without salt)
- Dehydration - sun, spray, freeze, hot air, etc.
- Thermal procession – canning (Appert), pasteurization (Pasteur), UHT, etc.
- Separations – dry milling, membrane, centrifugation, etc.
- Freezing – (Birdseye) and refrigeration

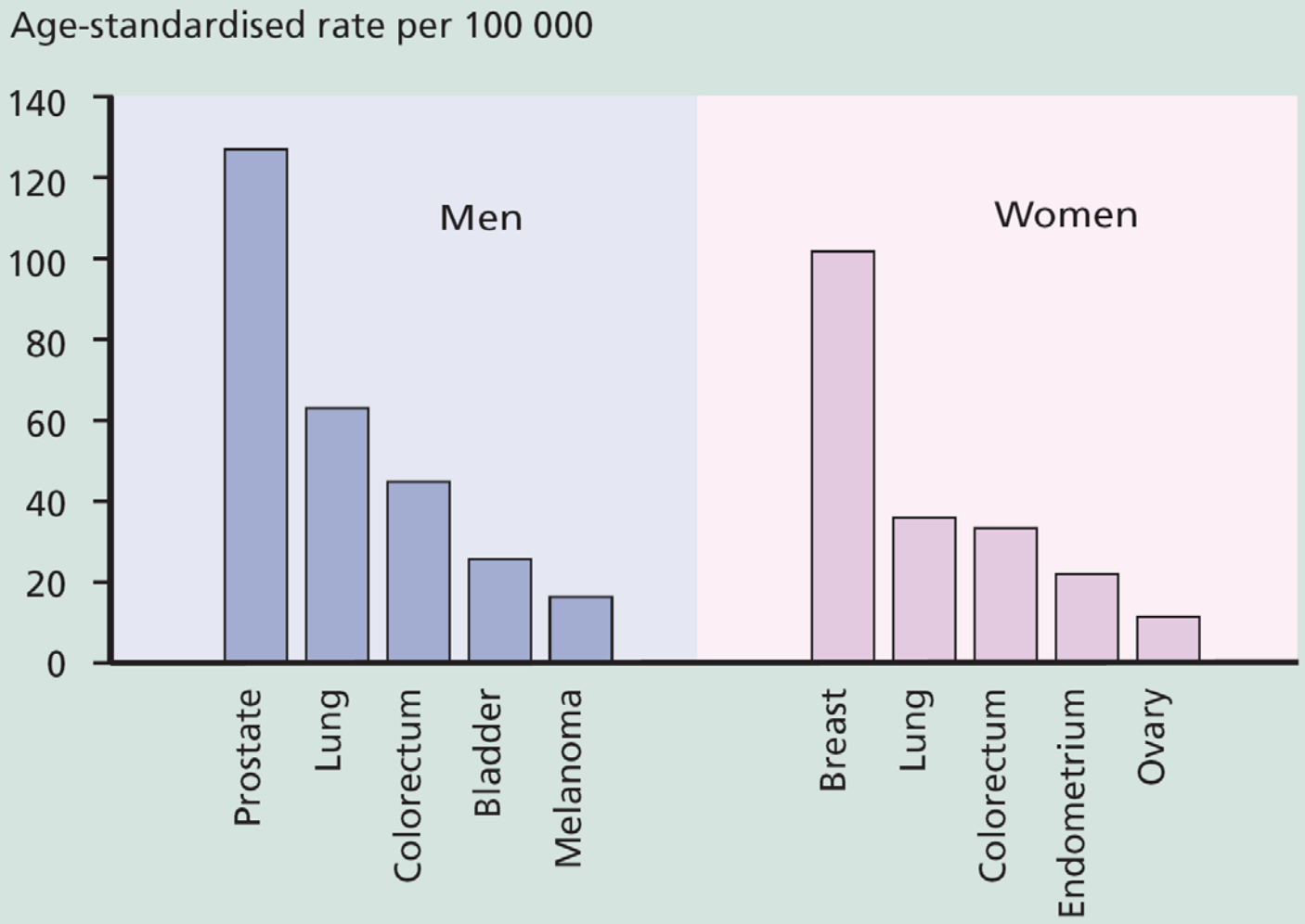
Benefits

- Protection from microbiological and chemical hazards
- Provision of a diversity of foods year-round
- Reduction of food shortages
- Reduction of spoilage while maintaining consistent taste and acceptability
- Increase convenience and reduce time needed to prepare foods

Cancer Incidence

- Does it vary throughout the world?
- Genetics and/or Environment?

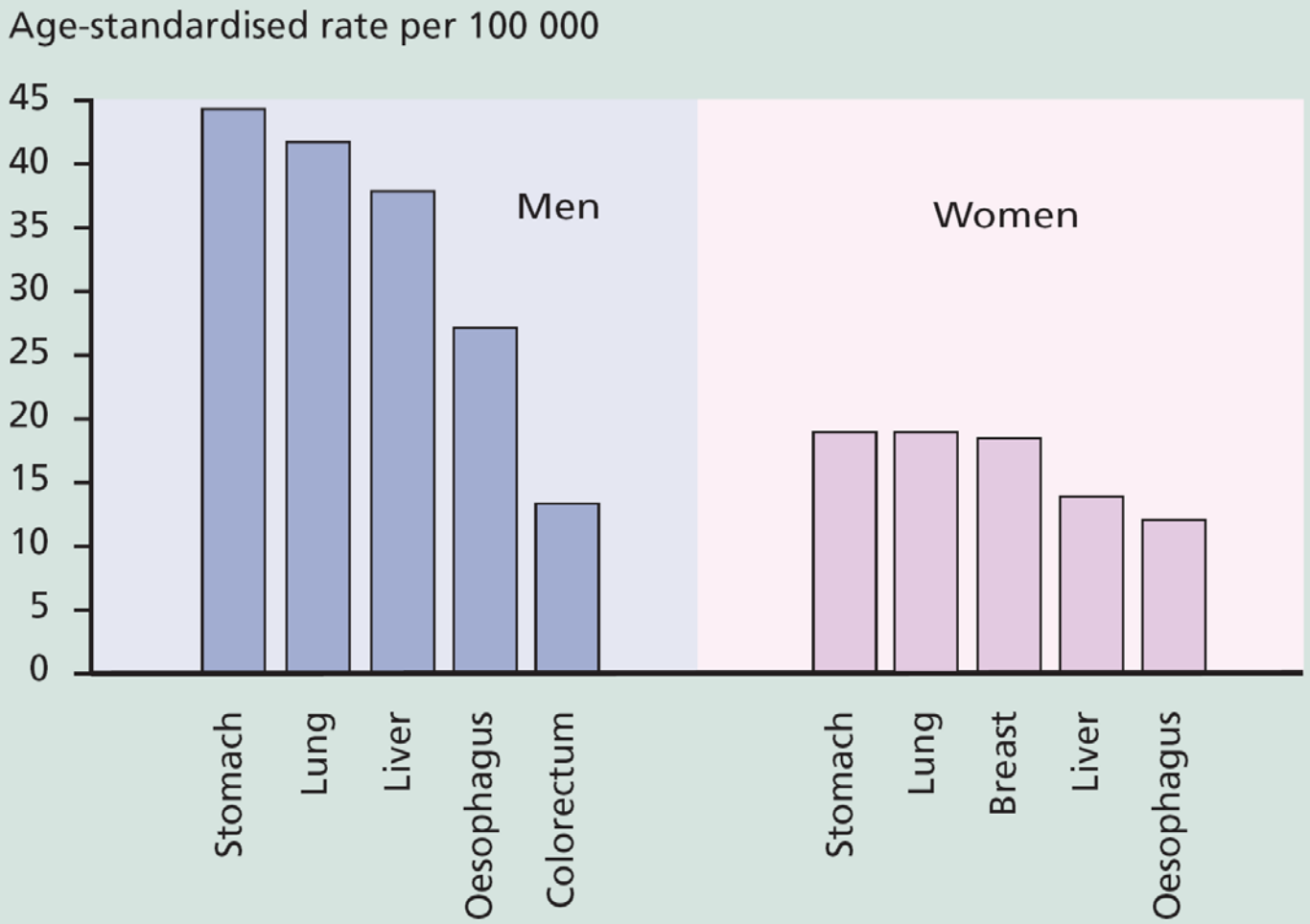
Age-standardised rates of common cancers USA



Data from International Agency for Research on Cancer[20]

World Cancer Research Fund | American Institute for Cancer Research

Age-standardised rates of common cancers China



Data from International Agency for Research on Cancer[20]

World Cancer Research Fund
American Institute for Cancer Research

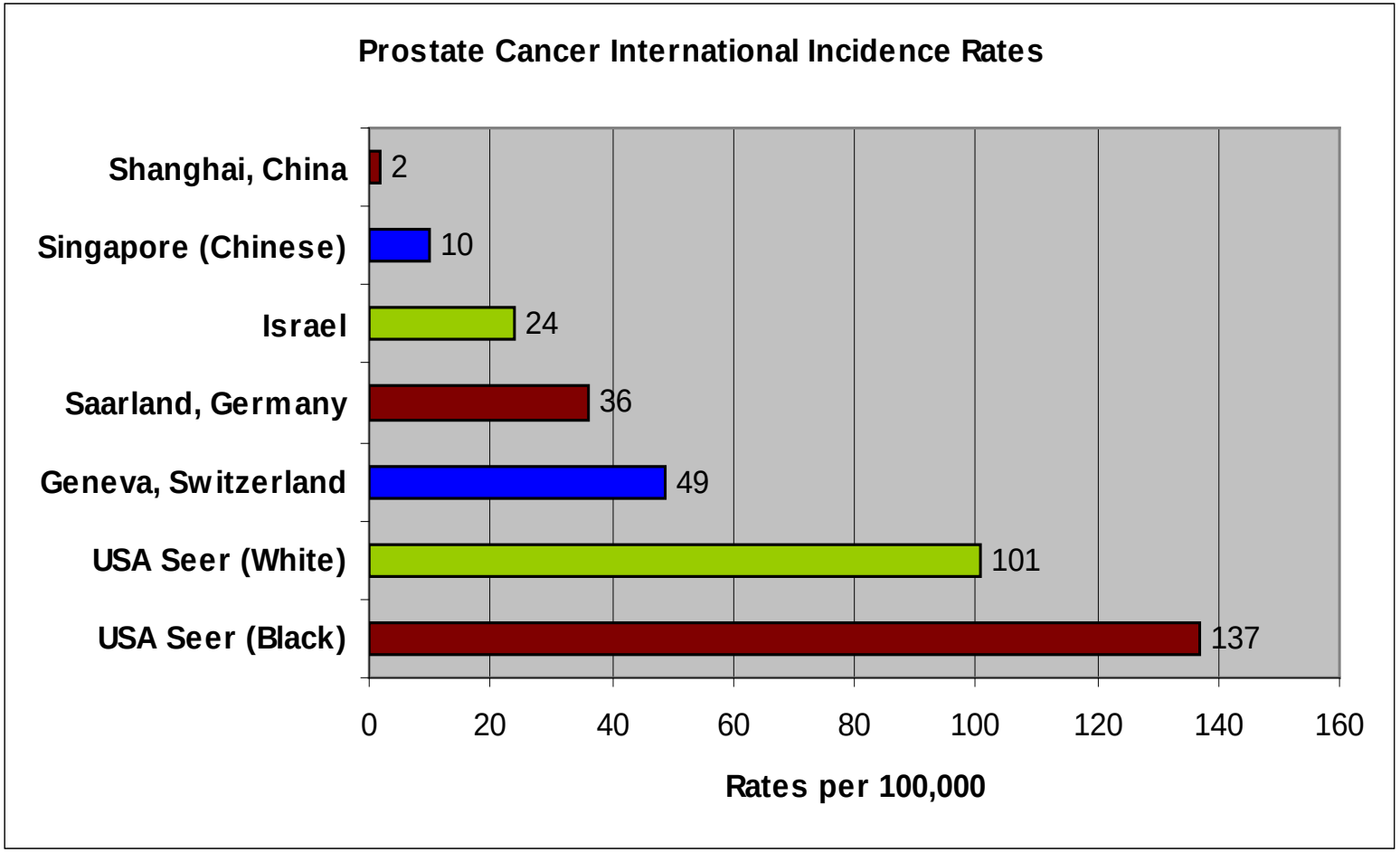
Estimated Deaths

Male	Female
Lung & bronchus 90,810 (31%)	Lung & bronchus 71,030 (26%)
Prostate 28,660 (10%)	Breast 40,480 (15%)
Colon & rectum 24,260 (8%)	Colon & rectum 25,700 (9%)
Pancreas 17,500 (6%)	Pancreas 16,790 (6%)
Liver & intrahepatic bile duct 12,570 (4%)	Ovary 15,520 (6%)

Genetics or Environment?

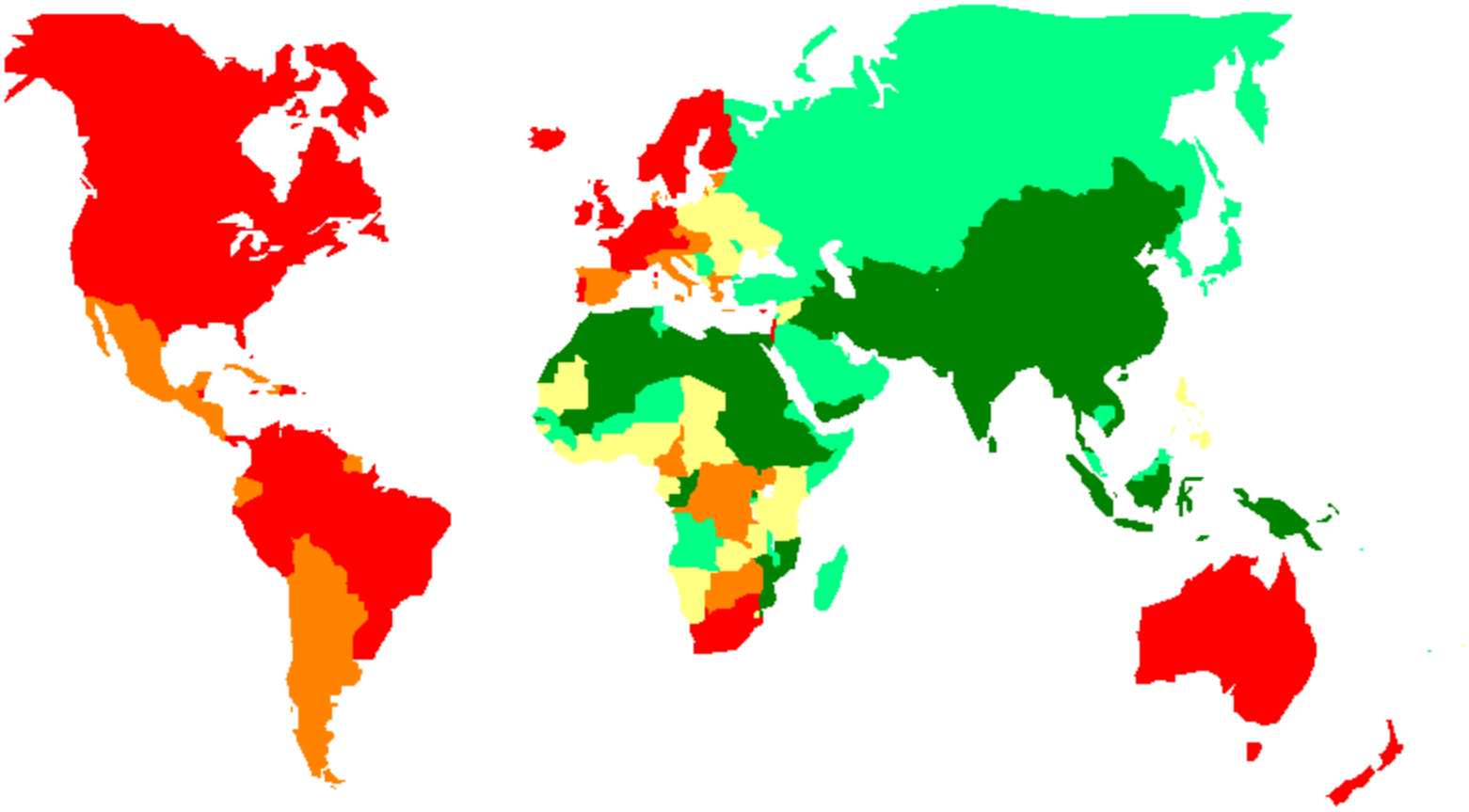
- **Smoking** is a major environmental factor
  - 90% of lung cancer is related to smoking
  - 30% of all cancers are related to smoking

SEER



–Stanford, et al. ***Prostate Cancer Trends 1973-1995*** **1999; NIH Pub. No. 99-4543 Ed**

Prostate
Age-Standardized incidence rate per 100,000



GLOBOCAN 2002, IARC

Genetics or Environment?

- **Both are important!**
- **Genetics is more related to early onset, aggressive cancers**

How much will dietary choices impact cancer incidence, severity and timing?

- Sir Richard Doll predicted in 1981 that 35% of cancer incidence was due to dietary factors

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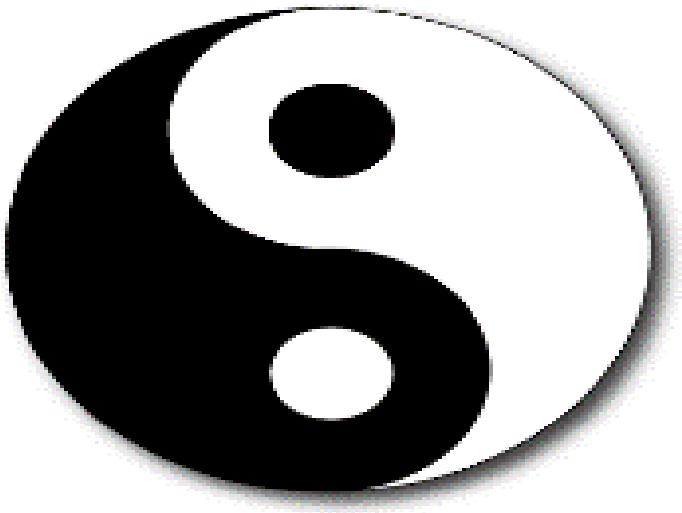
Ying -Yang of Food Processing



Ying -Yang of Cooking

- Excess heat reduces vitamin C, folic acid, and some B vitamins

- Appropriate heating reduced food safety concerns and enhances digestibility of foods and bio-accessibility to nutrients for absorption

Lycopene bioavailability enhanced by:

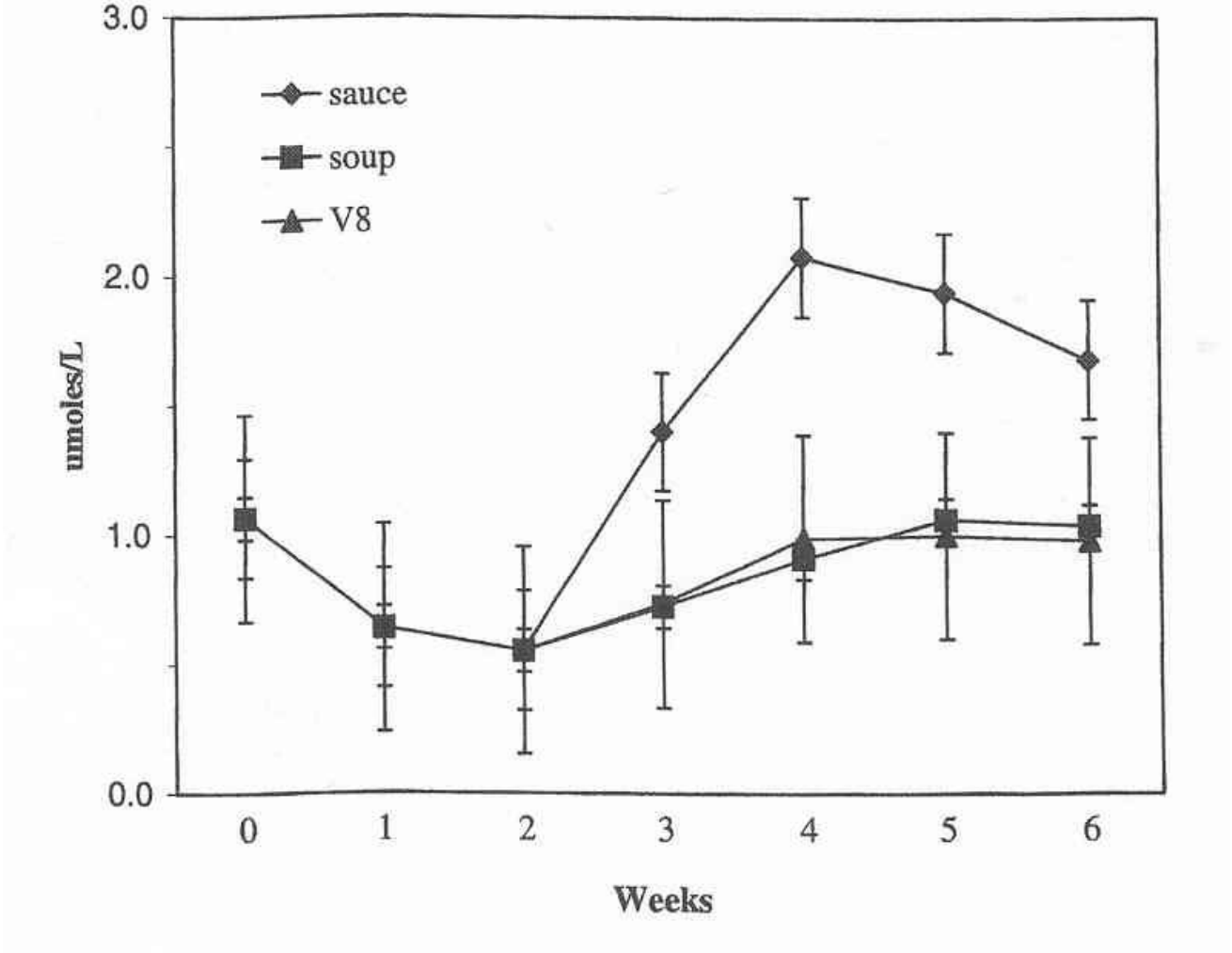
Cooking releases lycopene by disrupting cell walls and tissue structures

Heat weakening and dissociates lycopene-protein complexes

Heat dissolves crystalline lycopene aggregates

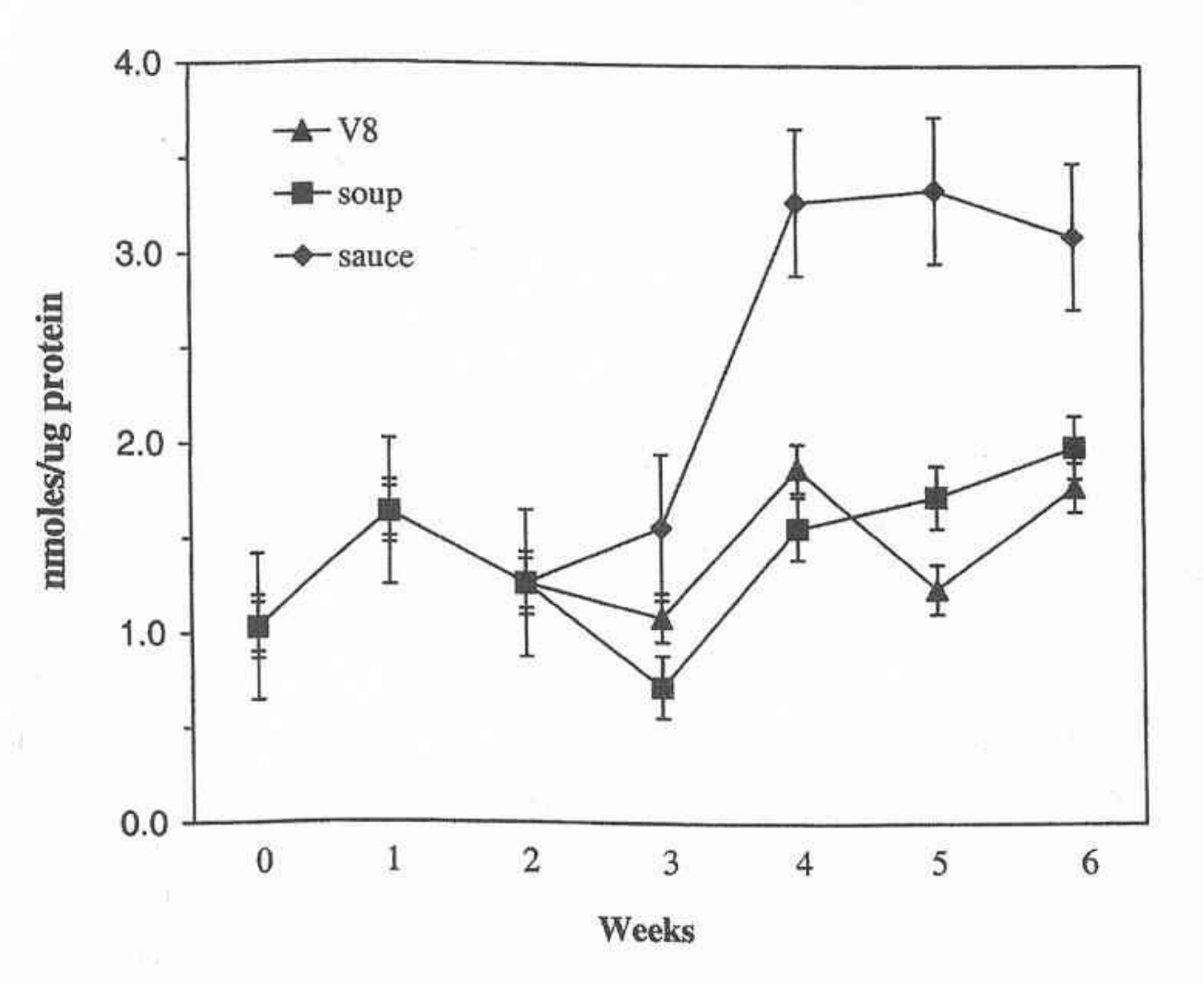
Result is that heat enhances absorption of lycopene

Blood Lycopene following Daily Intake of Processed Foods



Allen et al., Nutrition & Cancer, 2003

Buccal Mucosal Lycopene Concentrations



Allen et al., Nutr. Cancer 2003

Cooked and Cured Meat

Evidence strongly suggests:

- Enhanced colorectal cancer risk with high intake of processed meats
- An association of high intake of salted fish and oral cancer
- Cooking meat to “well-done” (grilling or charbroiling) can produce a variety of carcinogens
- Curing with salt, nitrate or nitrite, or by smoking can increase cancer risk

Cooked and Cured Meat

Meta analysis of studies of red and processed meat and gastric cancer risk

1. Processed meat consumption associated with 45% increased risk
2. High intakes of beef, bacon, ham and sausage are risky
3. No association found with pork

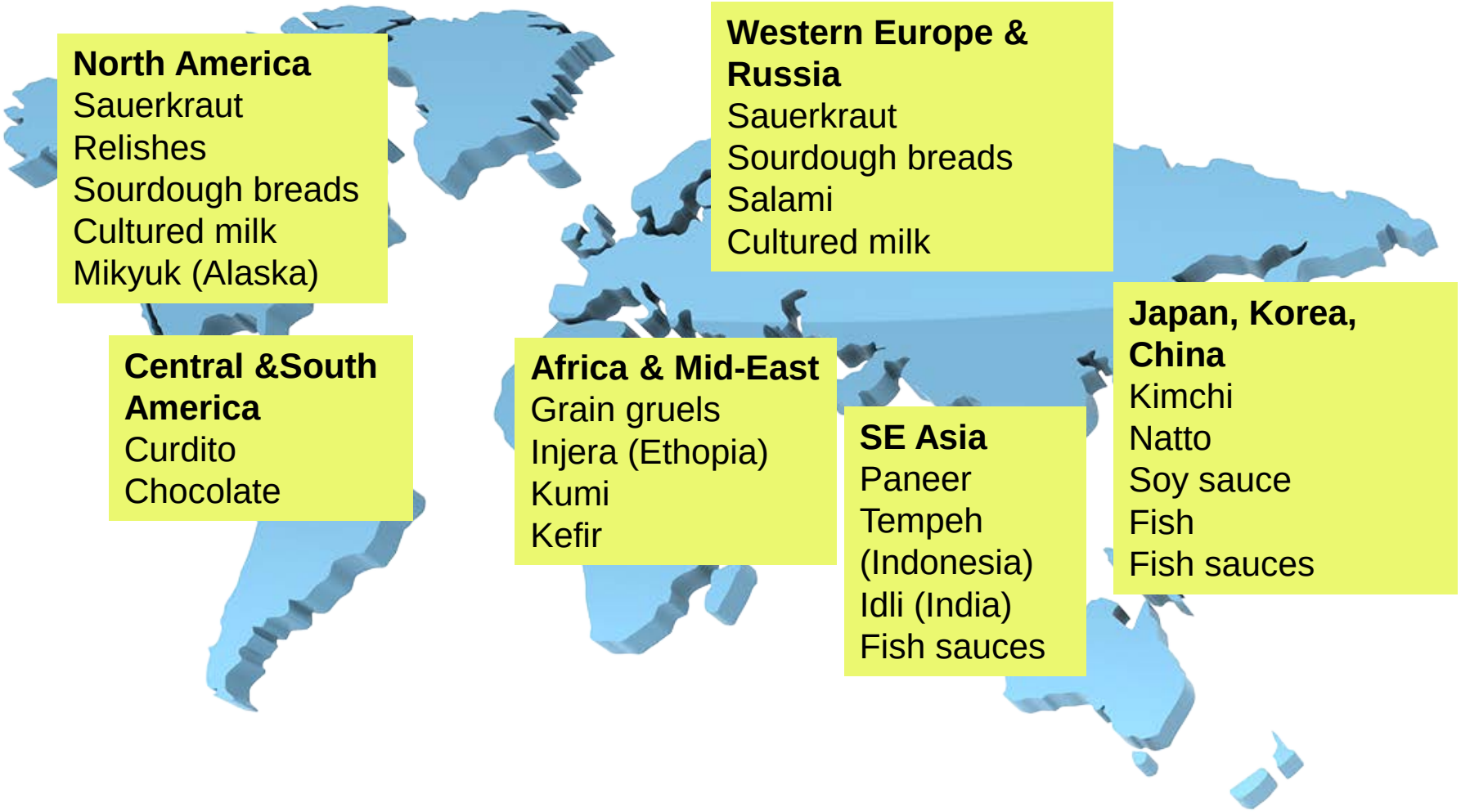
Zhu et al, PLOS ONE (Aug, 2013)

What should we do regarding red meat?

- Limit the number of weekly servings processed and smoked meat
- Heat/grill meats at lower temperatures
- Avoid having fat drop directly on coals or a direct flame
- Control portion size

What fermented foods do we eat?

legumes ▪ grains ▪ vegetables ▪ fruit ▪ milk ▪ fish ▪ meat



Steinkraus, KH (ed*), Handbook of Indigenous Fermented Foods*, 1983.

Pickling

(fermenting in water with or without salt)

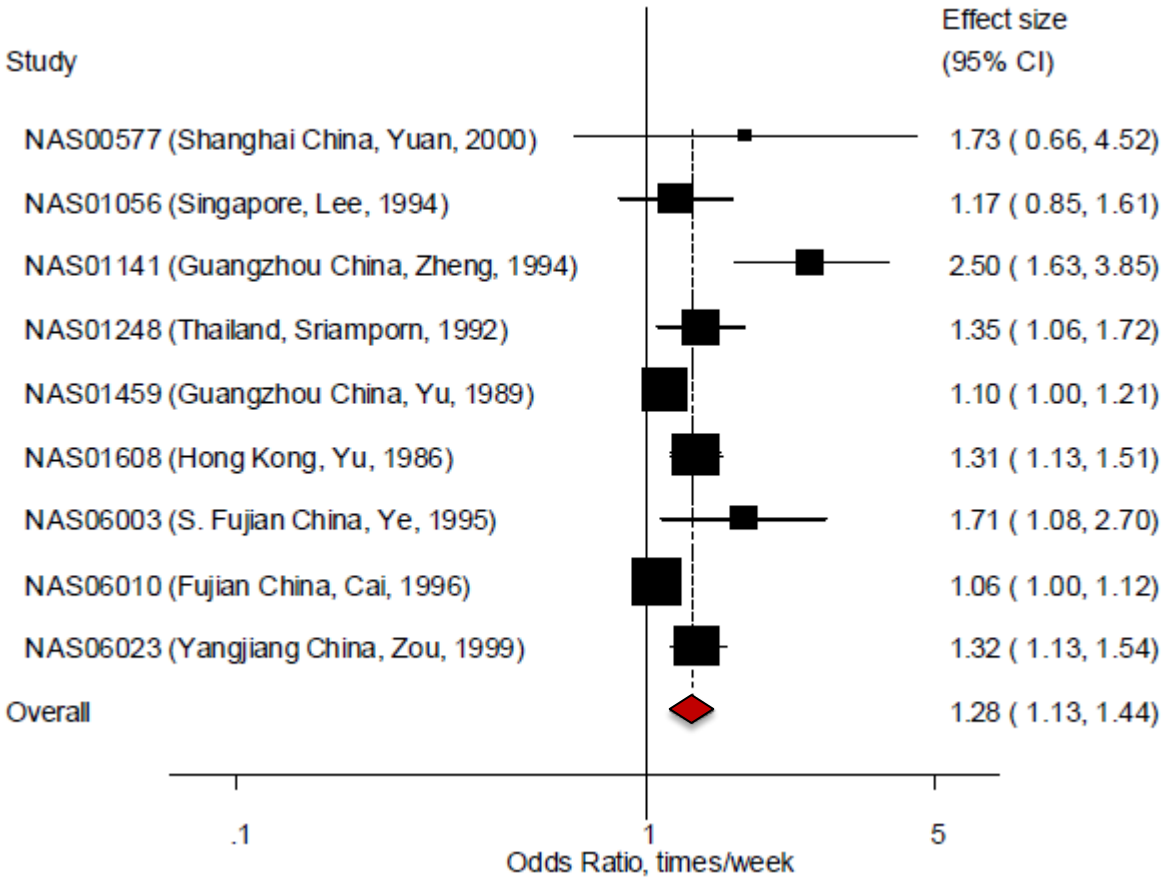
- Preserving, soaking or storing in vinegar or brine/salt.
- Fermentation products generated:
  - May cause adverse effects:

    -- *N*-nitroso compounds (NOCs), mycotoxins
  - May offer health benefits:

    -- anti-microbial; viable bacteria in non-pasteurized products

Kimchi

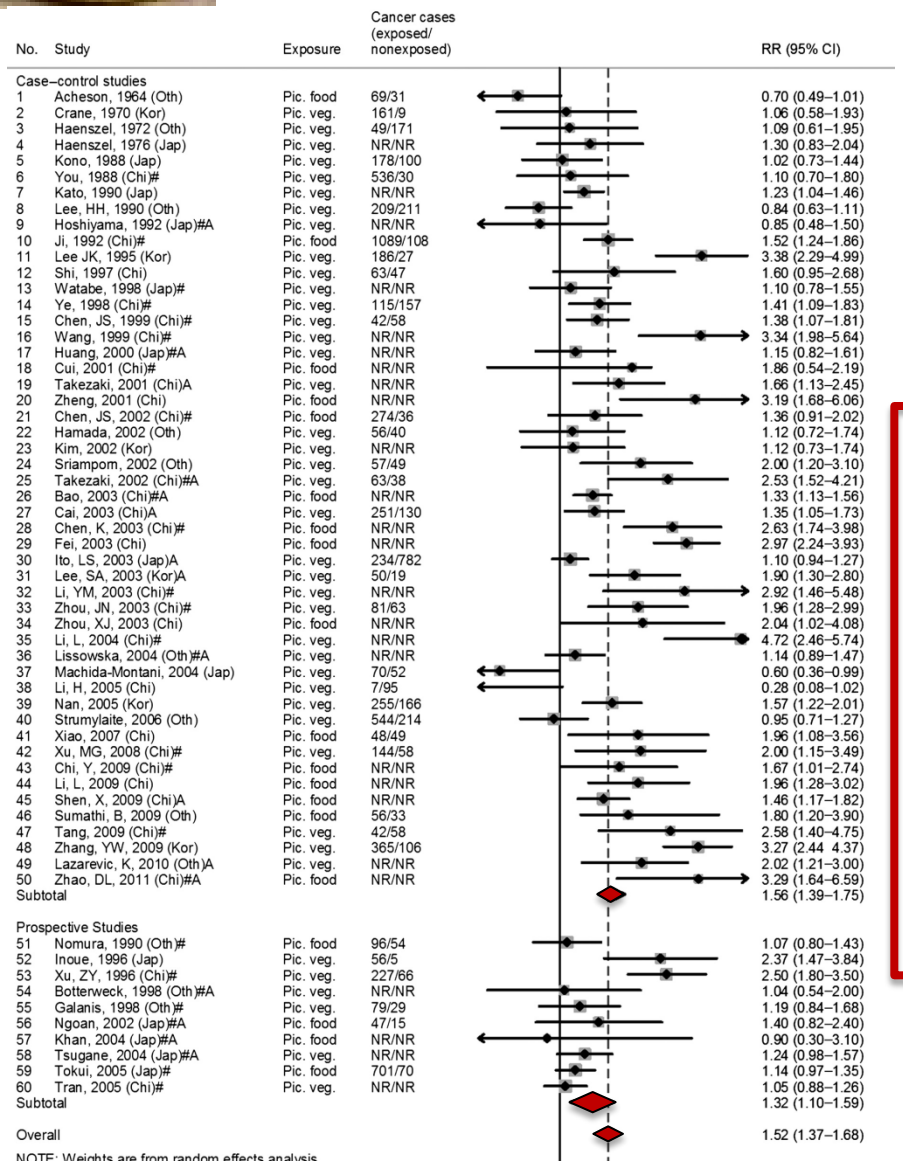
Salted Fish Intake and Oral Cancer



- High rates in Hong Kong, Singapore, southern China.
- 28% increased risk of oral cancer
- Association appears stronger for early life exposure to salted fish (0-3 y)

AICR/WCRF: http://dietandcancerreport.org

Pickled Food and Gastric Cancer: Meta analysis of 60 studies



- high-risk for gastric cancer when pickled foods are eaten daily

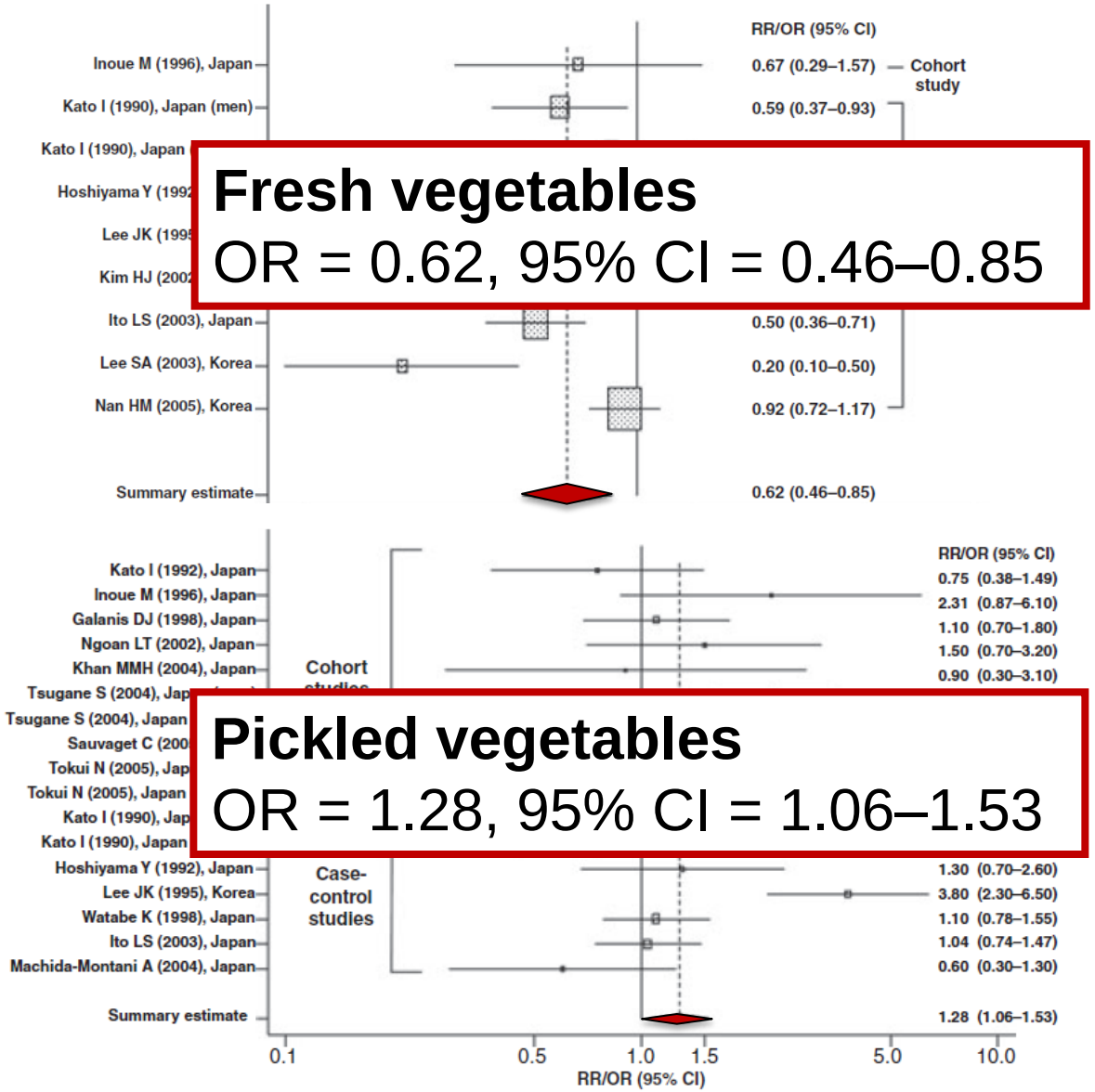
RESULTS

Overall Risk of Gastric Cancer:

- OR = 1.52 (95% CI 1.37–1.68)

Ren et al, *Cancer Epi Biomarkers Prev*, 21:905, 2012

Fresh Verses Pickled Vegetable Consumption and Gastric Cancer in Japan and Korea



- Meta analysis of studies of vegetables and gastric cancer risk:
  - -- 8 fresh
  - -- 14 pickled

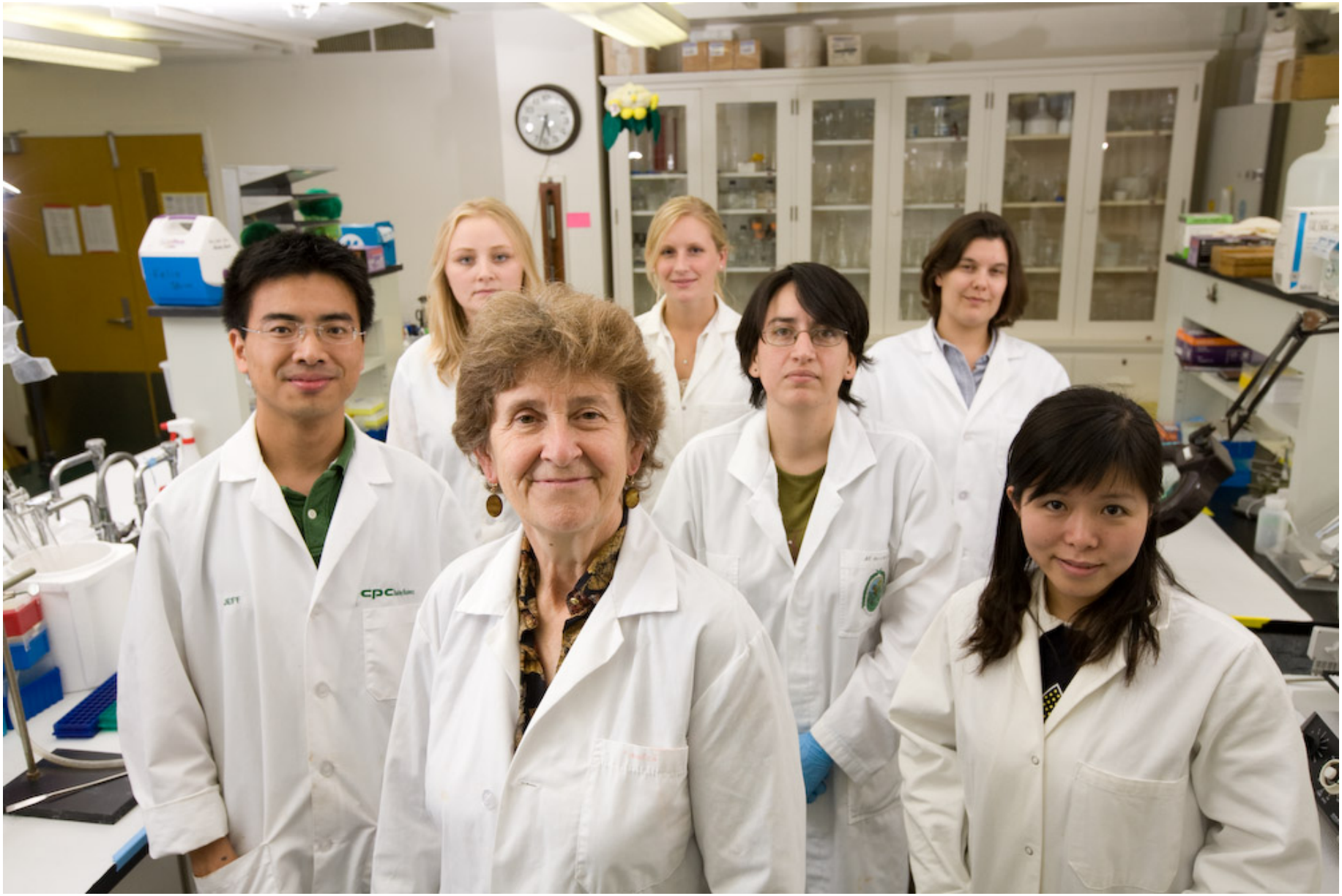
Kim et al, *Cancer Sci*, 101:508, 2010

Fermented Foods and Cancer
What do we do?

- Generally in the U.S. there is limited intake of pickled/fermented foods and salted foods - Moderation
- They are usually not consumed in isolation
- Fermented dairy products generally provide health benefits, especially if there are live cultures
- Future observational studies will benefit from distinguishing more explicitly between different types of fermented foods

Crucifers lower risk for cancers more effectively than do vegetables, in general

	RR	
		Colon
All vegetables	**0.75 (p=0.43)**	**Voorrips et al, 2000**
Cruciferous	**0.51 (p=0.004)**	(low verses high quintile)
		Prostate
All vegetables	**0.81 (p=0.15)**	**Cohen et al, 2000**
Cruciferous	**0.54 (p=0.01)**	(ratio <1:>3 servings/wk)



Mette Sondergaard Jenna Cramer Sonja Volker

Ren-Hau Lai Marcela Araya Ning Zhu

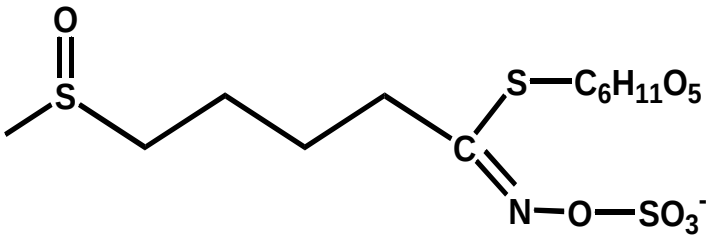
Broccoli retains substantial amounts of vitamin C during home processing, depending upon the cooking method

Raw Broccoli	117 mg/100 g
High pressure	88
Steam	117
Microwave	64
Boiling	86

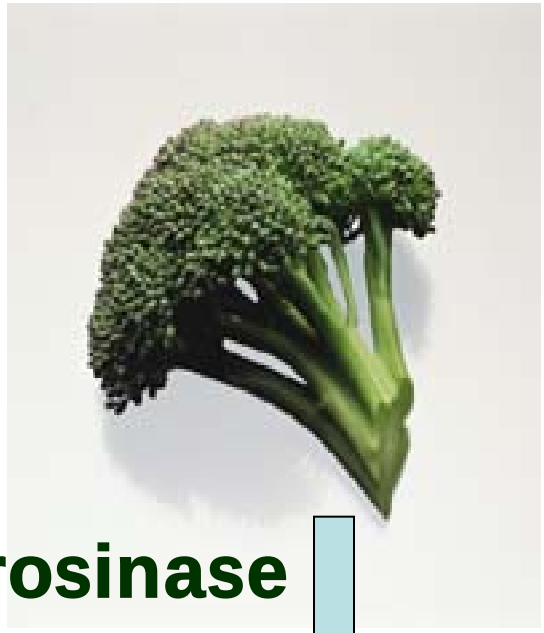
150 g fresh-cut Marathon broccoli

Vallejo et al, 2002

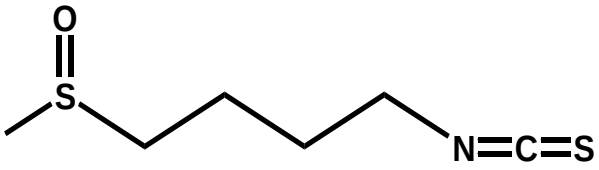
BUT glucosinolates require hydrolysis to produce the anti-carcinogen - sulforaphane.



Glucoraphanin



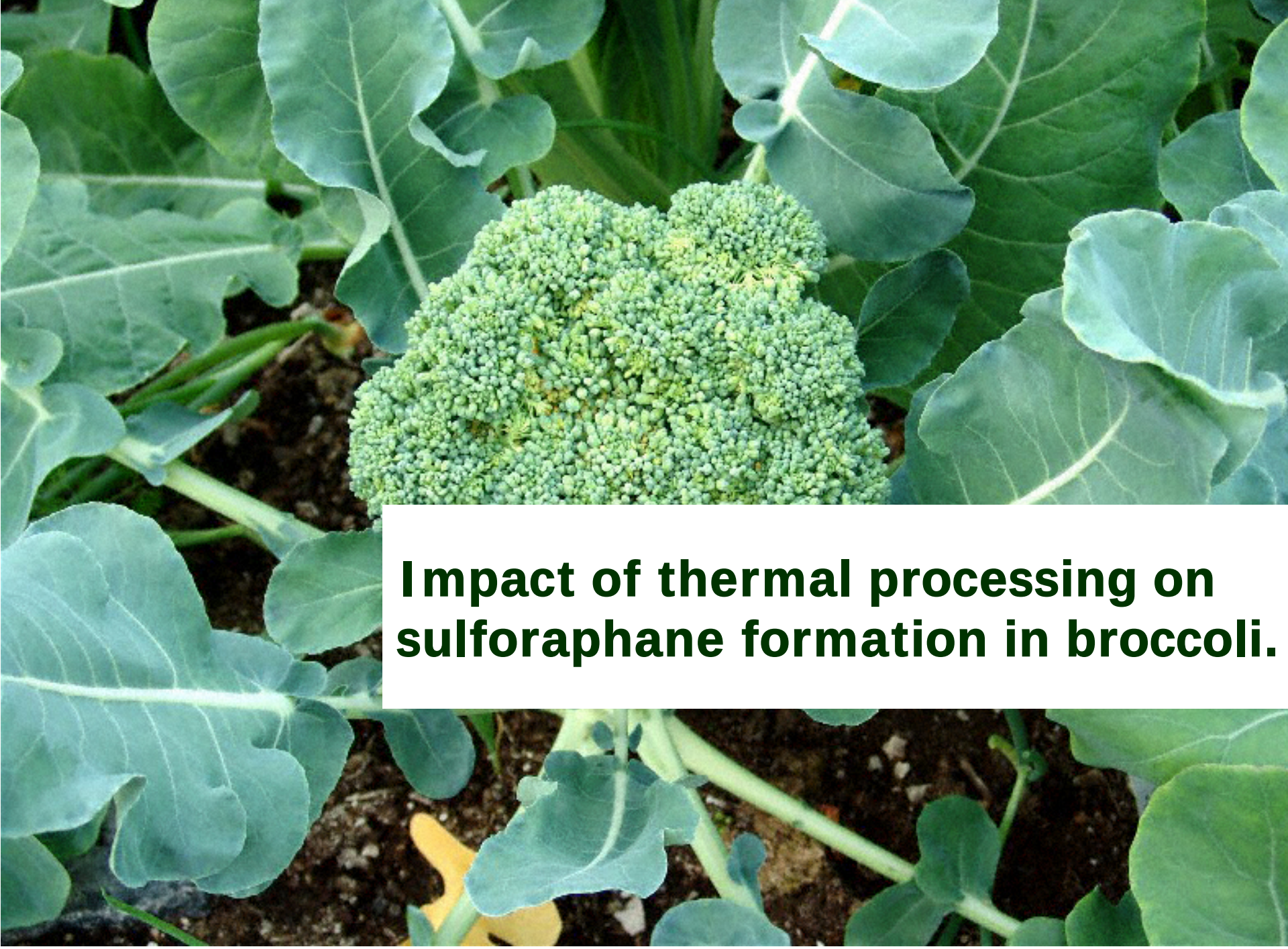
Myrosinase



Sulforaphane

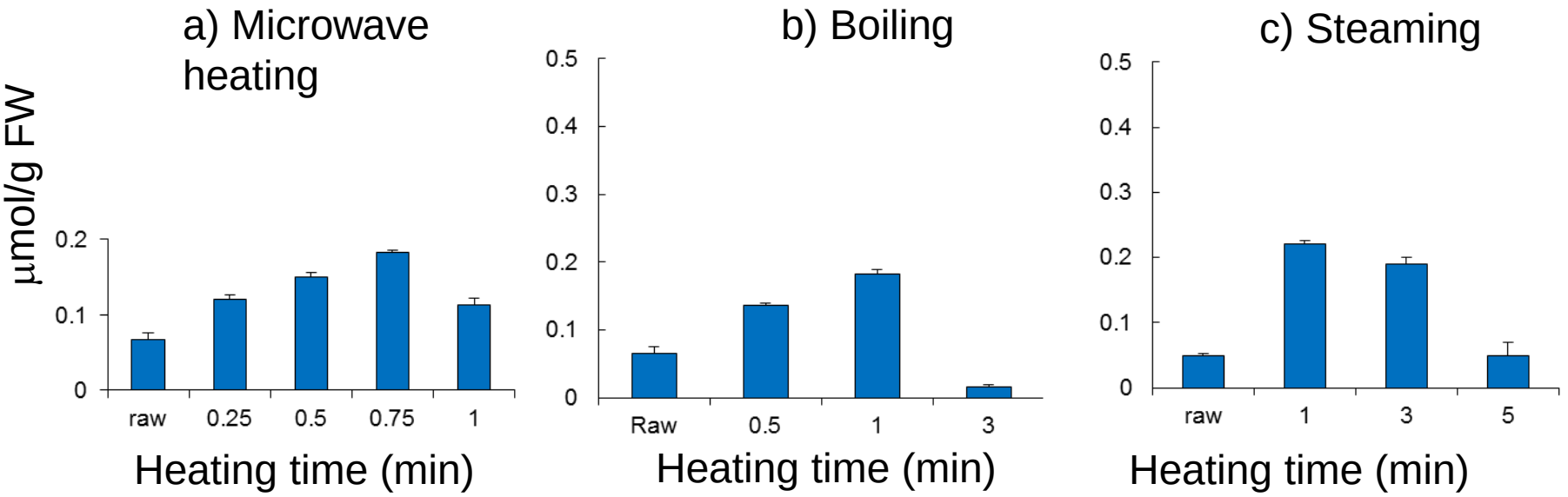
ITC

Isothiocyanate
Anticarcinogen



Impact of thermal processing on sulforaphane formation in broccoli.

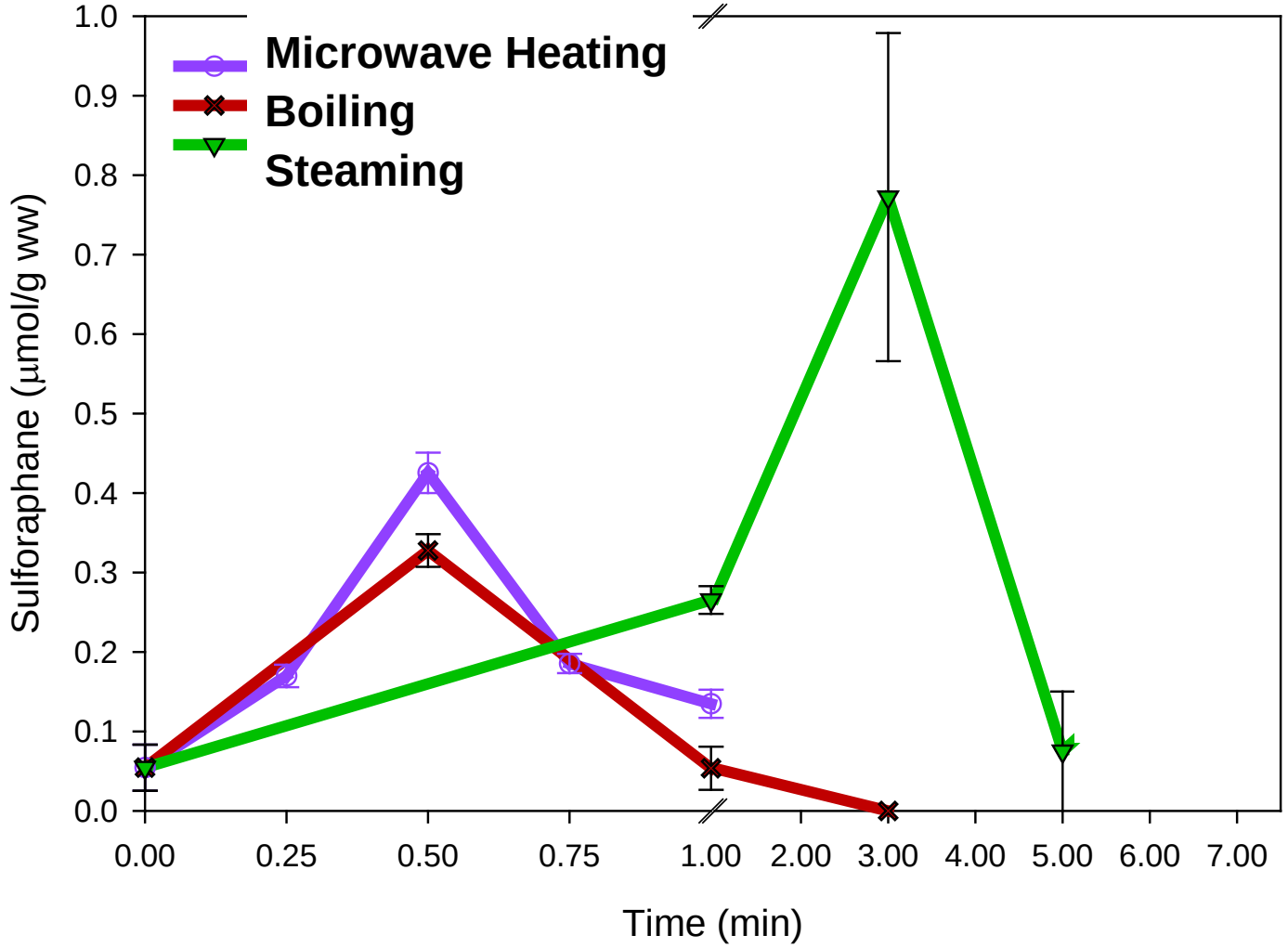
Impact of heating on glucoraphanin hydrolysis to sulforaphane in fresh Marathon broccoli



Marathon broccoli (n=3; 100 g each, a compilation from 4 heads) was heated by a) microwave in a covered dish with 30 mL water ; b) boiling in 1L water; c) steaming.

Wang et al, 2012

Comparison of Heating Methods for Optimizing GP Hydrolysis to Sulforaphane



TAKE HOME MESSAGE

Fact 1: the health effects of broccoli are strong and deserve to be harnessed

Fact 2: sulforaphane is so unstable, the plant keeps it conjugated (as glucoraphanin) - when free it rapidly degrades

Fact 3: this stable conjugate requires an enzyme myrosinase to release sulforaphane

Fact 4: Broccoli processing should protect myrosinase to provide more dietary sulforaphane

Relative Risk of Prostate Cancer

	Number of Servings				***P* for Trend**
	0	1-3/mo	1/wk	2-4/wk	
Carrots	1.0	1.18	1.22	1.14	0.540
Spinach	1.0	1.00	0.97	1.22	0.510
Broccoli	1.0	0.96	0.76	1.05	0.170
Tomato Sauce	**1.0**	**0.85**	**0.77**	**0.66**	**0.001**
Tomatoes	**1.0**	**0.90**	**0.91**	**0.91**	**0.030**
Pizza	**1.0**	**0.94**	**0.76**	**0.85**	**0.050**
Tomato Juice	1.0	1.02	0.85	1.15	0.670

Giovannucci et al. ***J Natl Cancer Inst*** **1995; 87: 1767-76**

Lycopene consumption and prostate cancer risk
Health Professional Follow-Up Study

- **Zu, K., *et al., JNCI 106: online (2014)***
  - *The Giovannucci group at Harvard confirmed ~6,400 prostate cancer from ~49,000 men enrolled in 1986*

  - 1986-2010 – lycopene intake and cancer:
    - Total Prostate Cancer (RR: 0.92, *P* = 0.009)
    - Lethal Prostate Cancer (**RR: 0.72**, *P* = 0.04)

  - One Prior Negative PSA test
    - Total Prostate Cancer (RR: 0.88, *P* = 0.02)
    - Lethal Prostate Cancer (**RR: 0.47**, *P* = 0.009)

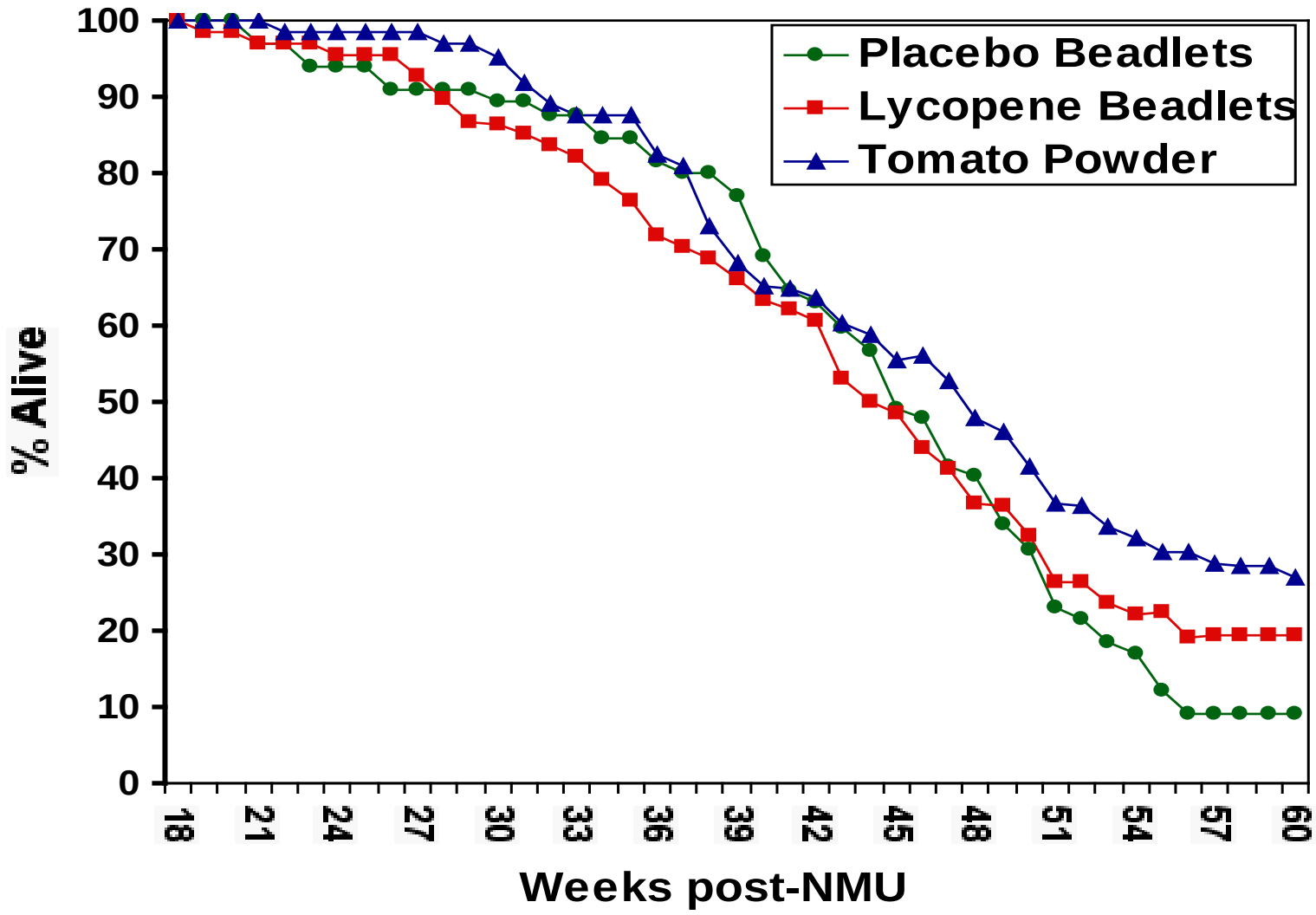

BOBBY VANS
GRILL
EXIT

Impact of Tomato Powder and Lycopene on Chemically-induced Prostate Cancer

- NMU Study in F344 rats on tomato versus lycopene alone
- Design - Diets
  - 10% tomato powder diet
  - Lycopene supplement diet
  - Control AIN-93 diet
  - Fed for over 1 year

Boileau et al. J of Natl. Cancer Inst. 95:1578-86 (2003)

Survival By Tomato Treatment

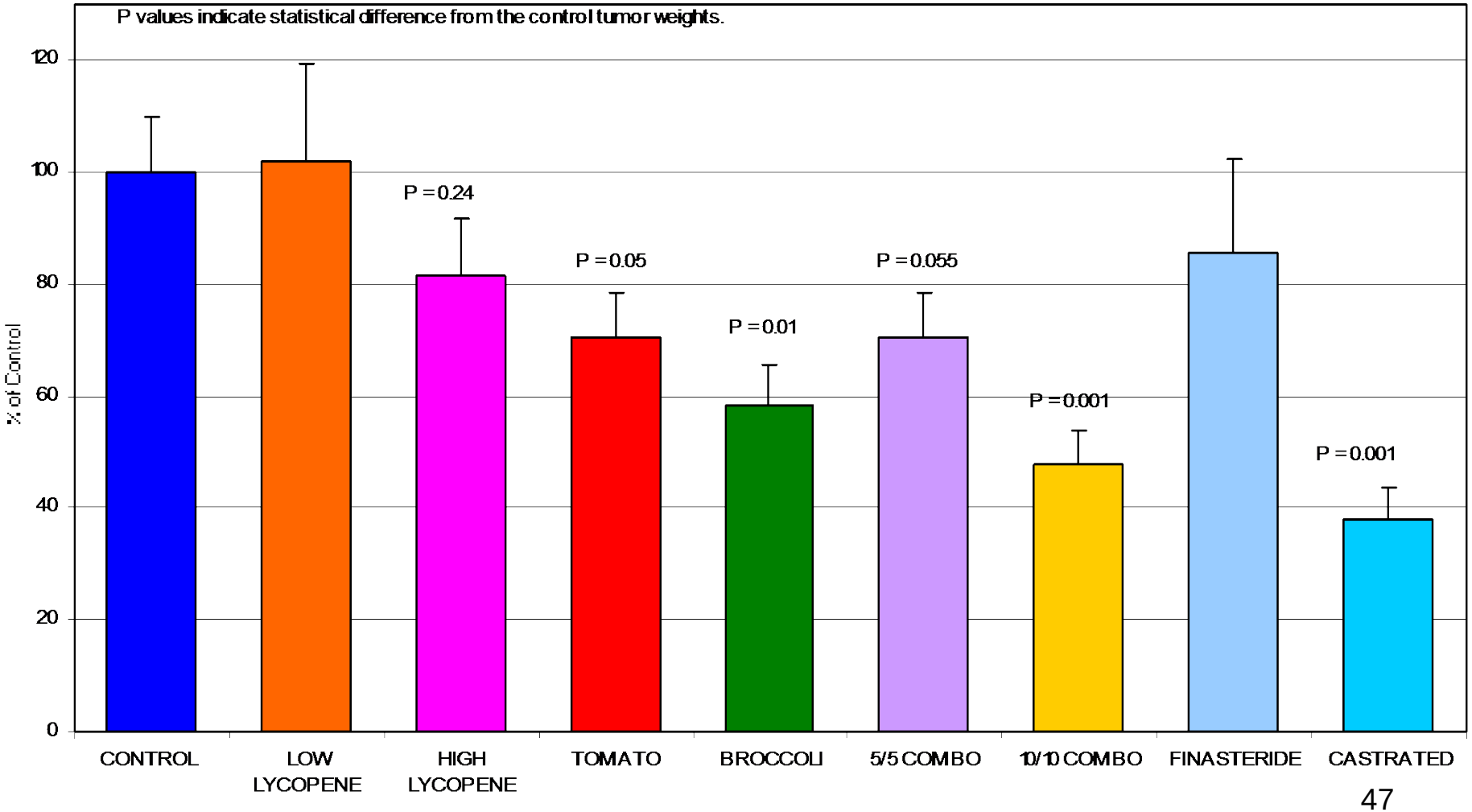


Impact of Tomato and Broccoli Powder and Lycopene on Transplantable Prostate Tumors

- Transplantable tumor model of prostate cancer in Copenhagen rats
- Tested impact of feeding various dietary treatments including freeze-dried whole tomato powder, broccoli powder or lycopene supplements

Canene-Adams et al (2007) Cancer Research 67:836-43

Dunning Tumor Weights



Broccoli & Tomatoes: Eat Them Together, Life Will Be Better

Impact of Tomato Powder +/- Soy Germ on Prostate Cancer in TRAMP Mice

Zuniga, Erdman and Clinton

University of Illinois

The Ohio State University

Zuniga et al, Cancer Prev. Res. 2013

Study Design

- 3 wk old male C57BL/6 x FVB TRAMP mice acclimated to modified AIN-93G diet for 1 wk

- Mice randomized to consume experimental diets for 14 weeks

Dietary Treatments

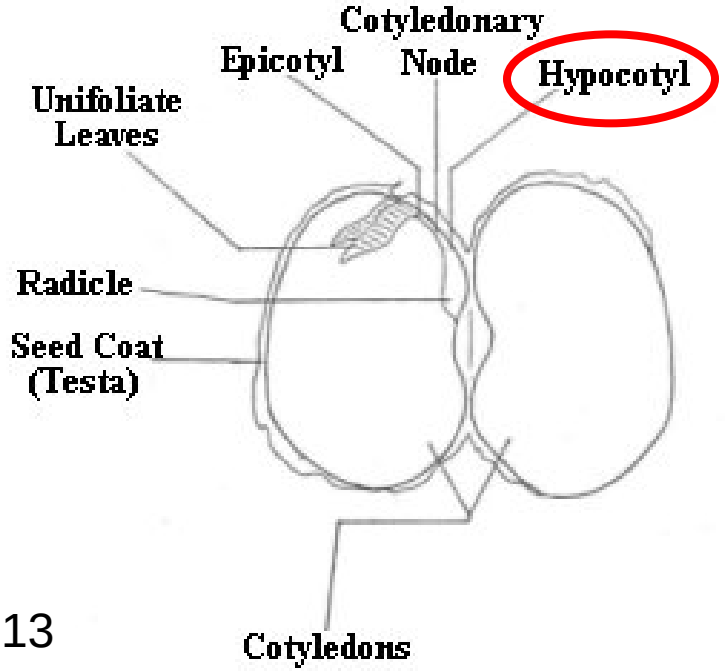
- AIN-93 G Control (n=29)
- 10% Tomato Powder (n=31)
- 2% Soy Germ (n=32)
- 10% Tomato Powder + 2% Soy Germ (n=27)

What is Soy Germ?

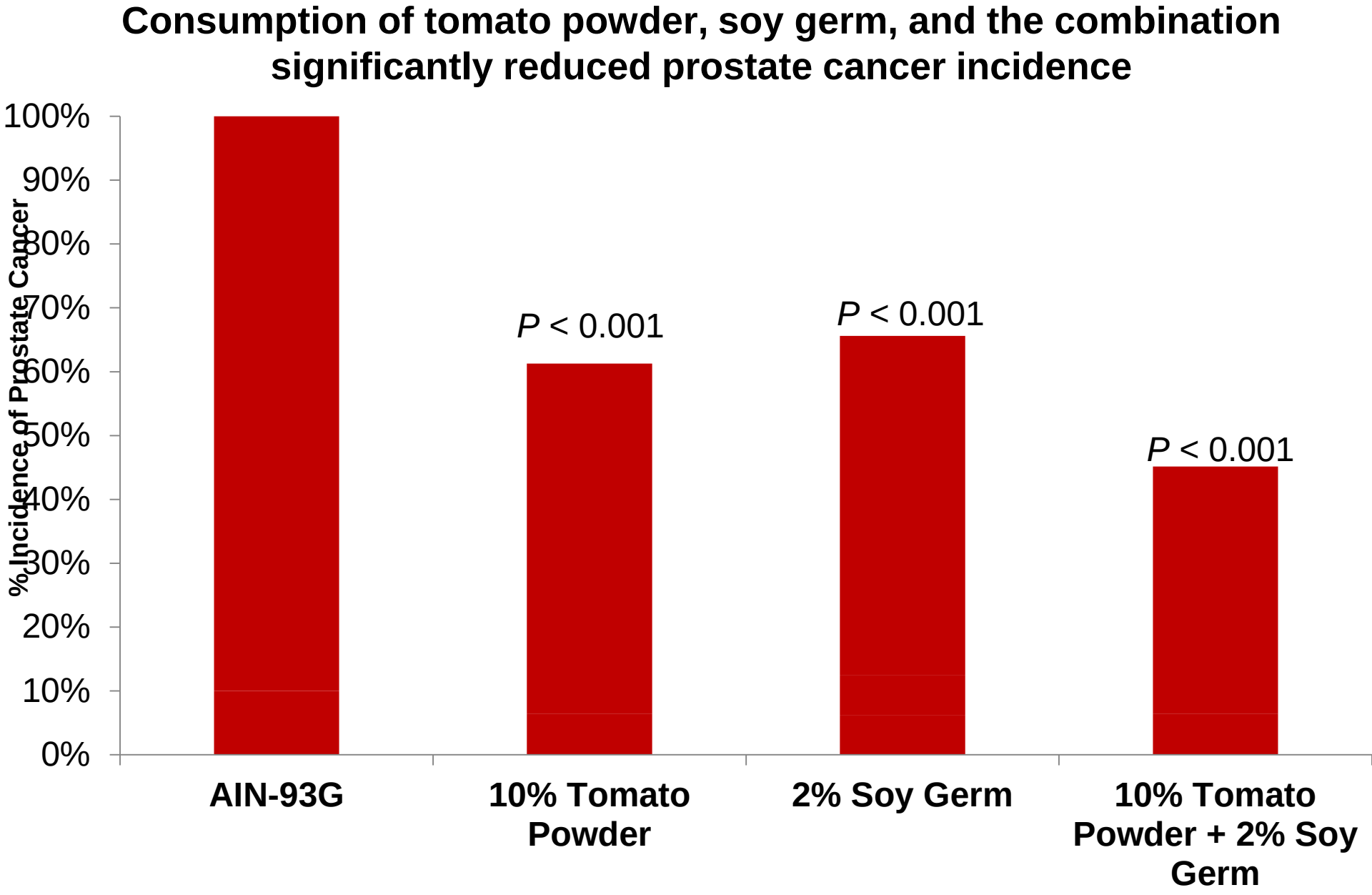
- Phytochemical rich fraction of the soybean.
- Potential anti-carcinogenic properties of becoming studied.
- Unique isoflavone profile

Frutarom Soy Germ: SoyLife® Complex Micro

SOYLIFE®



Zuniga KE, et. al. Cancer Prev Res 2013


Consumption of tomato powder, soy germ, and the combination significantly reduced prostate cancer incidence
% Incidence of Prostate Cancer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
P < 0.001
P < 0.001
P < 0.001
AIN-93G
10% Tomato Powder
2% Soy Germ
10% Tomato Powder + 2% Soy Germ

Cooked or Raw?

- Mild cooking enhances the absorption of bioactives from both tomato and broccoli

How Many Servings?

- About 3 servings per week of each vegetable appears to be related to less prostate cancer risk

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Conclusions

Peto was correct in 1981- about 35 % of cancer related to diet – much has to do with obesity and alcohol – but food and processing choices matter

- Don’t overcook,
- Limit processed red meat consumption
- Maintain weight and exercise
- 2/3 of plate should be plant based

Never too early or too late to follow appropriate general guidelines for cancer reduction

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WCRF/AICR web site

www.dietandhealthreport.org

RECOMMENDATIONS

BODY FATNESS
Be as lean as possible within the normal range of body weight

PHYSICAL ACTIVITY
Be physically active as part of everyday life

FOODS AND DRINKS THAT PROMOTE WEIGHT GAIN
Limit consumption of energy-dense foods
Avoid sugary drinks

PLANT FOODS
Eat mostly foods of plant origin

ANIMAL FOODS
Limit intake of red meat and avoid processed meat

ALCOHOLIC DRINKS

Limit alcoholic drinks

PRESERVATION, PROCESSING, PREPARATION

Limit consumption of salt

Avoid mouldy cereals (grains) or pulses (legumes)

DIETARY SUPPLEMENTS

Aim to meet nutritional needs through diet alone

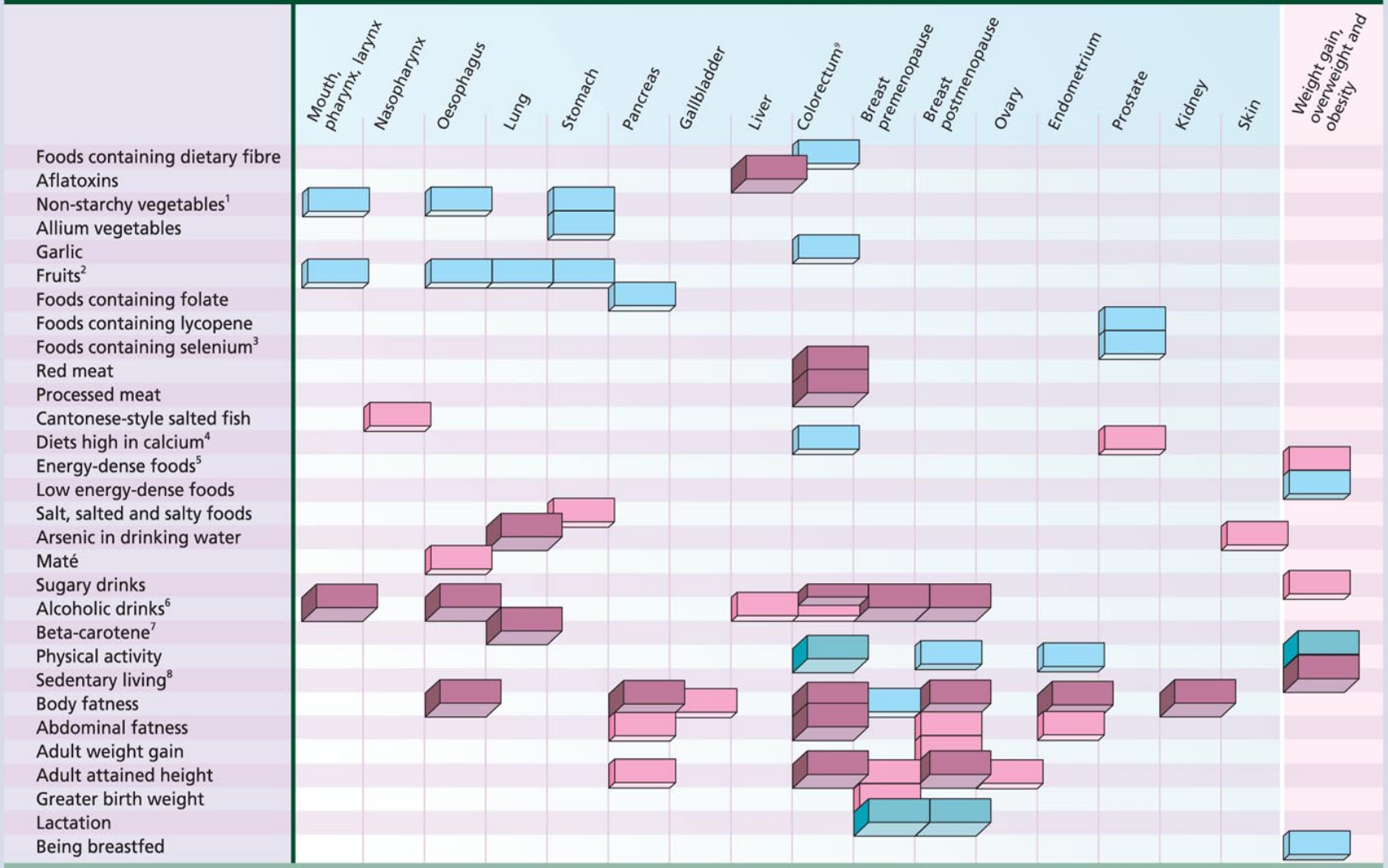
BREASTFEEDING

Mothers to breastfeed; children to be breastfed

CANCER SURVIVORS

Follow the recommendations for cancer prevention

Summary of 'convincing' and 'probable' judgements



KEY

- Convincing decreased risk
- Probable decreased risk
- Probable increased risk
- Convincing increased risk

[1] Includes evidence on foods containing carotenoids for mouth, pharynx, larynx; foods containing beta-carotene for oesophagus; foods containing vitamin C for oesophagus

[2] Includes evidence on foods containing carotenoids for mouth, pharynx, larynx and lung; foods containing beta-carotene for oesophagus; foods containing vitamin C for oesophagus

[3] Includes evidence from supplements for prostate

[4] Evidence is from milk and studies using supplements for colorectum

[5] Includes 'fast foods'

[6] Convincing harm for men and probable harm for women for colorectum

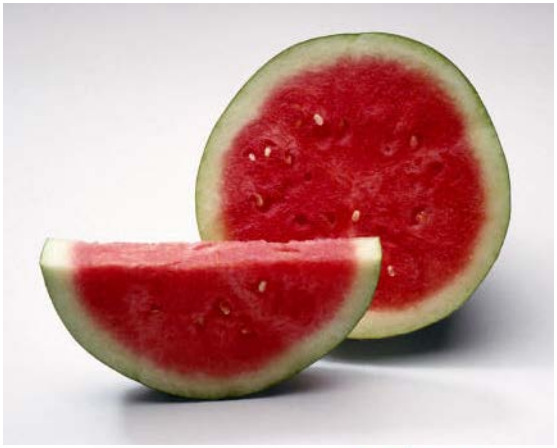
[7] The evidence is derived from studies using supplements for lung

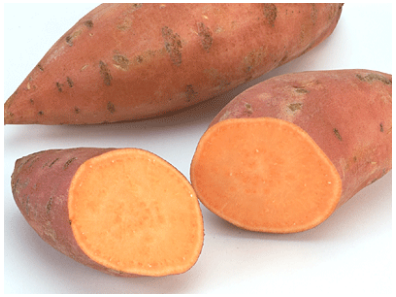
[8] Includes evidence on televison viewing

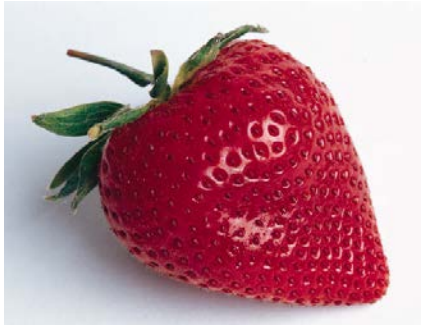
[9] Judgement for physical activity applies to colon and not rectum

World Cancer Research Fund

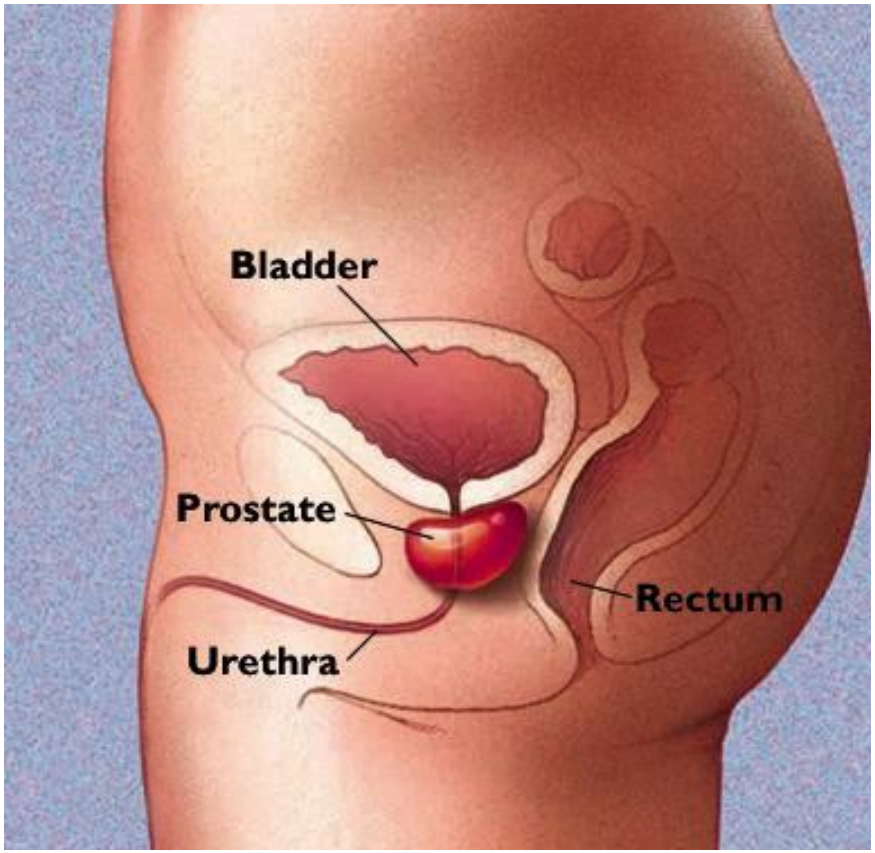
American Institute for Cancer Research







Prostate Gland



http://www.london-urology.co.uk/prostate%20side%20on.jpg