



FOOD, RICE AND ARSENIC: WHAT HEALTH PROFESSIONALS NEED TO KNOW

WHAT WE WILL EXPLORE TODAY

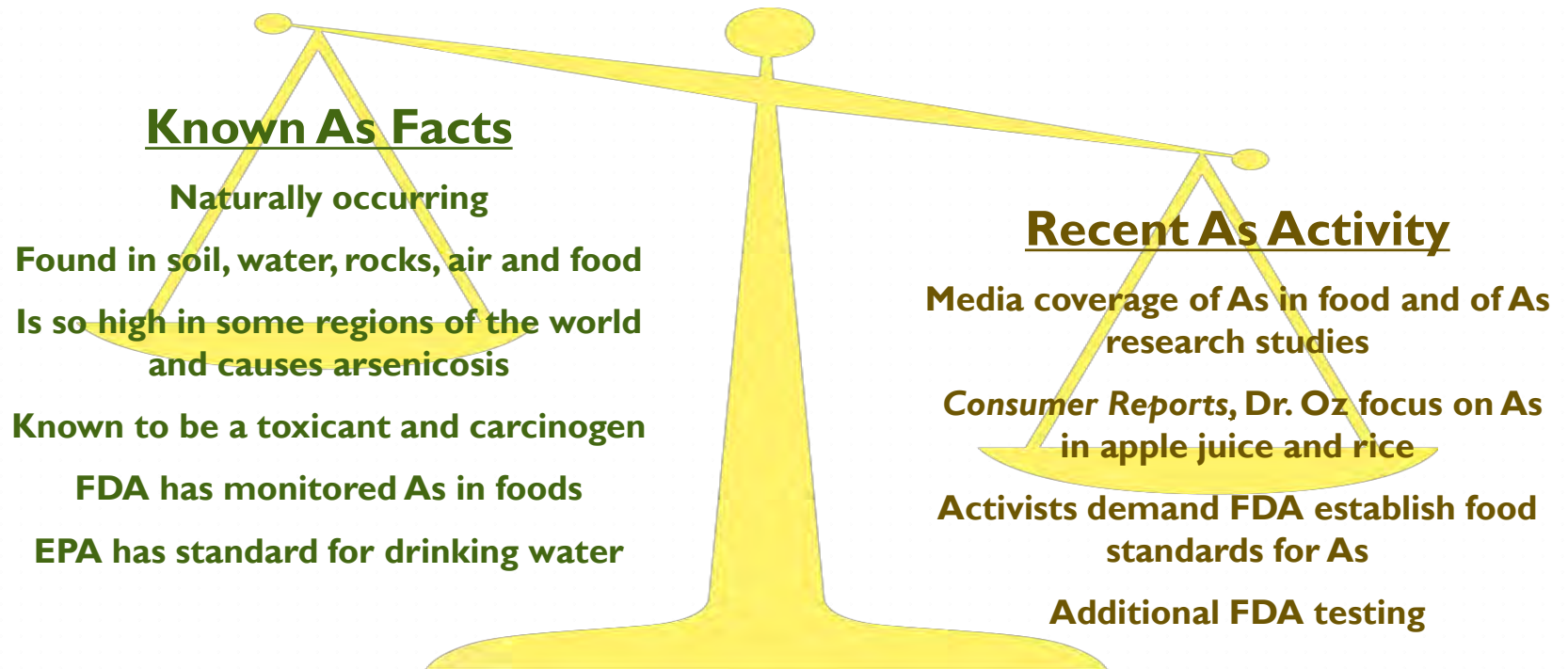
- ▶ What is prompting the concern about arsenic (As)?
- ▶ Arsenic in the environment, body and food supply
- ▶ Media scares in 2011 and 2012 and reassurances in 2013
- ▶ Recent FDA investigations and findings - As in food
- ▶ Protecting against As: what is the best strategy?
- ▶ Conclusion: analysis of As in the U.S. food supply requires no dietary changes

Julie Jones – PhD, CNS, LN,
Distinguished Scholar and
Professor Emerita
St. Catherine University
St. Paul, MN



Food safety and nutrition expert

ARSENIC (As) IS NEW IN THE NEWS BUT IS NOT NEW KNOWLEDGE



As a result of As in the news, consumers became fearful



ARSENIC IN THE ENVIRONMENT, BODY & FOOD SUPPLY

ARSENIC - BACKGROUND

- ▶ **As** - naturally occurring trace element
 - Ubiquitous - soil, air, water, plant-derived foods and fish
 - Distribution varies worldwide
- ▶ Trace amounts of As are unavoidably present in a variety of foods and beverages, whether grown using conventional or organic farming methods
 - As-based chemicals used in cotton production have not been substantiated as the cause of As in rice grown in the South
- ▶ **Water provides about 50% of a person's total As intake**
- ▶ Total As is not an important number because it is **inorganic (iAs)** that is toxic



33 As Arsenic 74.92160 $1s^2 2s^2 2p^6 3s^2 3p^3$ 9.7886	34 Se Selenium 78.96 $1s^2 2s^2 2p^6 3s^2 3p^4$ 9.7524	35 Br Bromine 79.904 $1s^2 2s^2 2p^6 3s^2 3p^5$ 11.8138
51 Sb	52 Te	53 I

A WORD ABOUT PPM AND MICROGRAMS

How Small is Small?

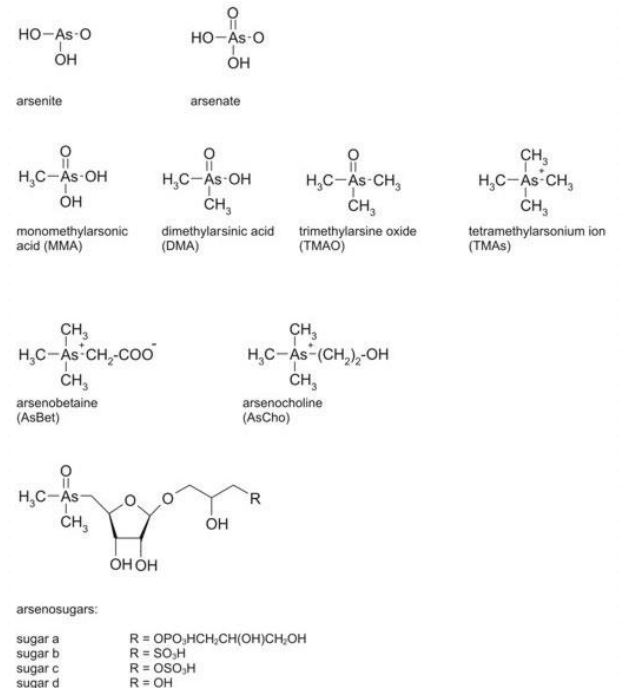
Unit	1 ppm (1 mg/kg)*	1 ppb (1 µg/kg)**
Time	1 minute/2 years	1 second/32 years
Money	1 cent/\$10,000	1 cent/\$10 million
Volume	1/4 tsp of water in a hot tub full of water	1 drop in an Olympic-sized swimming pool

There are calls for As to be less than 10 ppb in a variety of foods

- Also ~ 1 mg/L in dilute solutions
- **1/1,000,000th of a g
- µg = microgram
- 1,000 micrograms = 1 milligram (mg)

ARSENIC - ORGANIC AND INORGANIC

- ▶ **Total As** (inorganic + organic), often reported
- ▶ **Knowing the form of As** is critical because it determines human toxicity
 - ▶ **Inorganic As is much more toxic because organic forms are absorbed less and excreted more rapidly**
- ▶ Much U.S. rice has organic forms
 - ▶ The percent of inorganic As decreases linearly as total As increases
- ▶ High levels of total As don't necessarily equate to risk



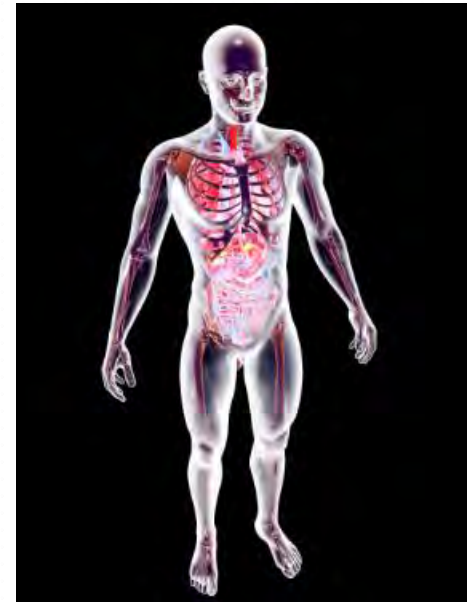
ARSENIC - METABOLISM

▶ Absorption

- 90% absorption from drinking water
- 60-70% absorption from food
 - ▶ Drinking water as a standard is not useful

▶ Metabolism

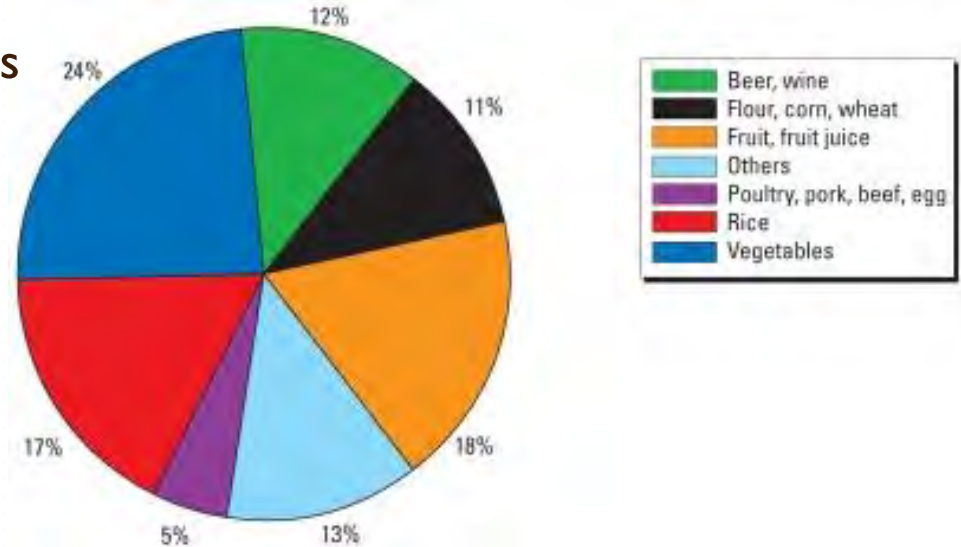
- **Organic forms** - fish (arsenobetaine, MMA and DMA)
 - ▶ Undergo limited metabolism and **do not readily enter the cell**
→ much less toxic
- **Inorganic**
 - ▶ As does not accumulate in the body
 - ▶ Majority of both forms found **unchanged** in the urine in 3-4 days
 - ▶ Sweating reduced all heavy metals, including As



ARSENIC IS FOUND IN ALL FOOD GROUPS

Food	Percent contribution of As
▶ Vegetables	24
▶ Fruits and juices	18
▶ Rice products	17
▶ Beer and wine	12
▶ Other grains	11
▶ Meat, eggs	5
▶ Other	13

- 75% organic
- Fish/shellfish – major source



- ▶ **Total As** intake 20 to 300 $\mu\text{g}/\text{day}$
- ▶ Contribution 10-25% inorganic

Eliminating any food group, including rice, won't address the problem

BIOAVAILABILITY OF ARSENIC IN RICE

Levels of Inorganic As

- ▶ Bran layers of brown rice - highest As
- ▶ Bioavailability differs in rice products
 - Extra long grain (Basmati) > long grain > long grain parboiled > brown rice
 - While brown has the most, it is the least bioavailable
- ▶ **Looking at the amount of As does not indicate what is absorbed**



ARSENIC HAS LONG BEEN PART OF FDA TOTAL DIET STUDY

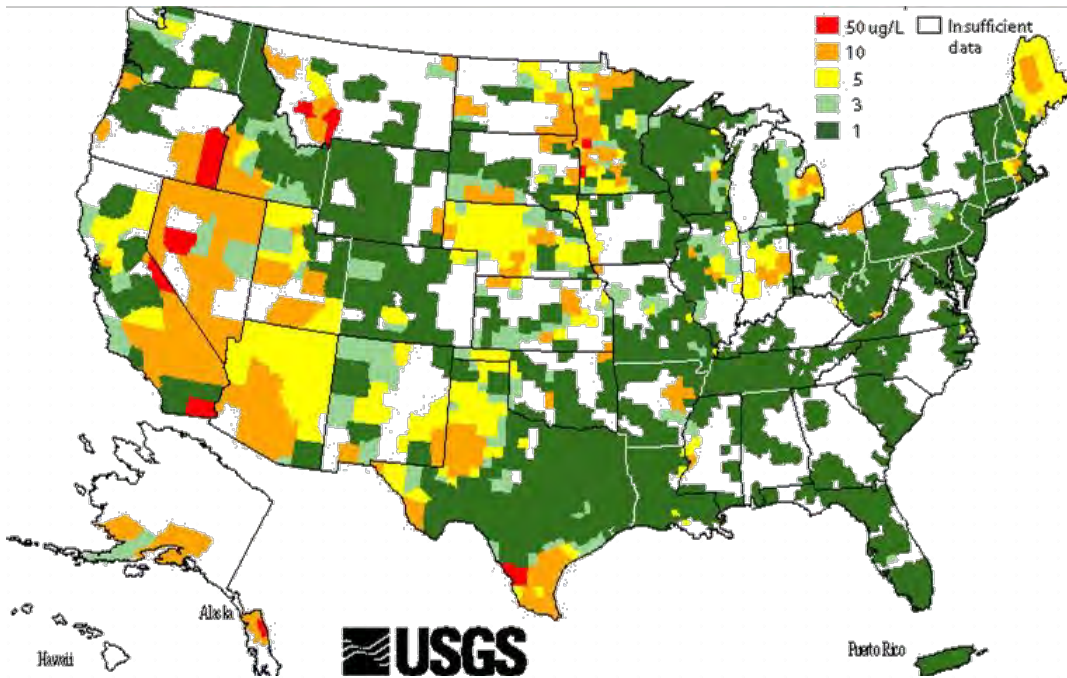
As levels in foods monitored for >20 years

- ▶ “parts-per-billion” (ppb) levels of total As
 - Older analysis did not distinguish organic and inorganic forms of As
- ▶ Conducting market basket study – on-going
 - FDA is currently analyzing As species in a number of foods, including rice
 - ▶ Special emphasis on foods consumed by children
- ▶ Sept 2012 – *Consumers Reports* sounds the alarm
 - Preliminary data from FDA and others show
iAs in U.S. rice significantly lower than CODEX rice data



ARSENIC LEVELS VARY WIDELY THROUGHOUT THE UNITED STATES

As CONCENTRATIONS IN AT LEAST
25% OF SAMPLES EXCEED:
MICROGRAMS/L OR WATER



▶ U.S. Geological Survey has measured minerals, including As levels, in the U.S. for decades

- ▶ ~ 50% U.S. water has $< 1 \mu\text{g}/\text{kg}$ (ppb)
- ▶ 90% has $< 10 \mu\text{g}/\text{kg}$ (ppb)
- ▶ Significantly less than the global average

Note – color assigned if As occurred at that level in 25% of samples

ALL PLANTS TAKE UP ARSENIC FROM THE SOIL

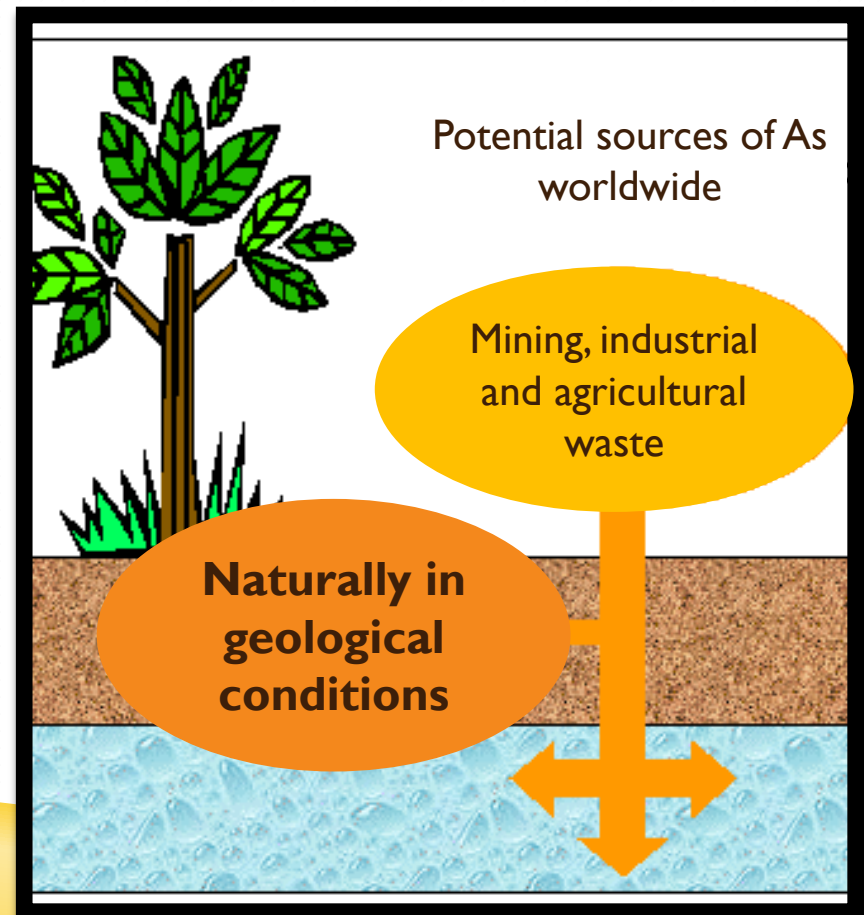
Rice – As is taken up from flooded paddies

- Rice is a silicon-accumulating, hence As-accumulating, plant
 - Some variation in this property by cultivar

No arsenical pesticides are used in U.S. rice production

Despite claims that As pesticides used in cotton fields are the source of As content of U.S. grown rice, there is no available evidence to support the claim

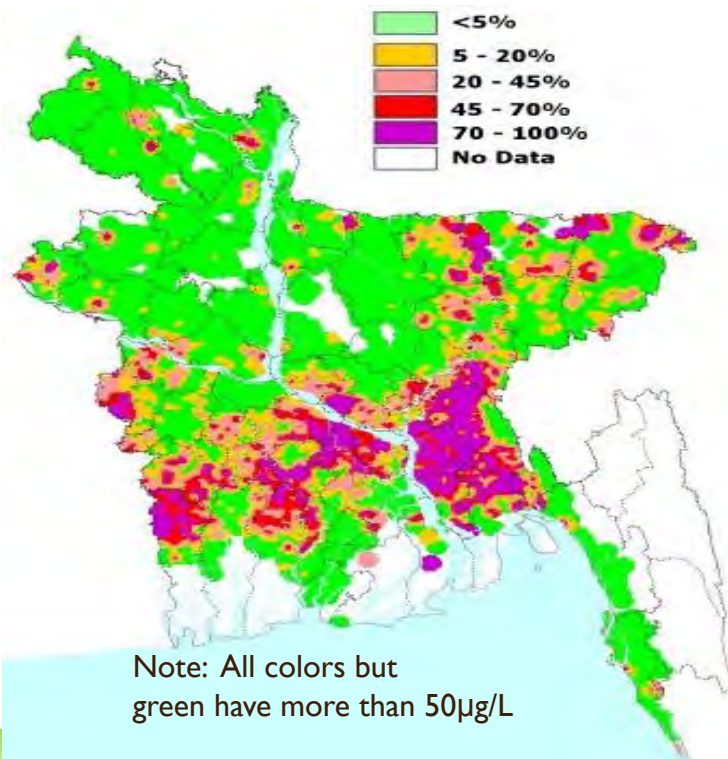
http://www.epa.gov/oppsrrd1/reregistration/organic_arsenicals_fs.html#changes



EXTRAPOLATION TO THE U.S. FROM AREAS WITH HIGH ARSENIC MAKES NO SENSE

Bangladesh As Map

PROBABILITY OF As EXCEEDING 0.05 $\mu\text{g/L}$



Arsenicosis In Bangladesh

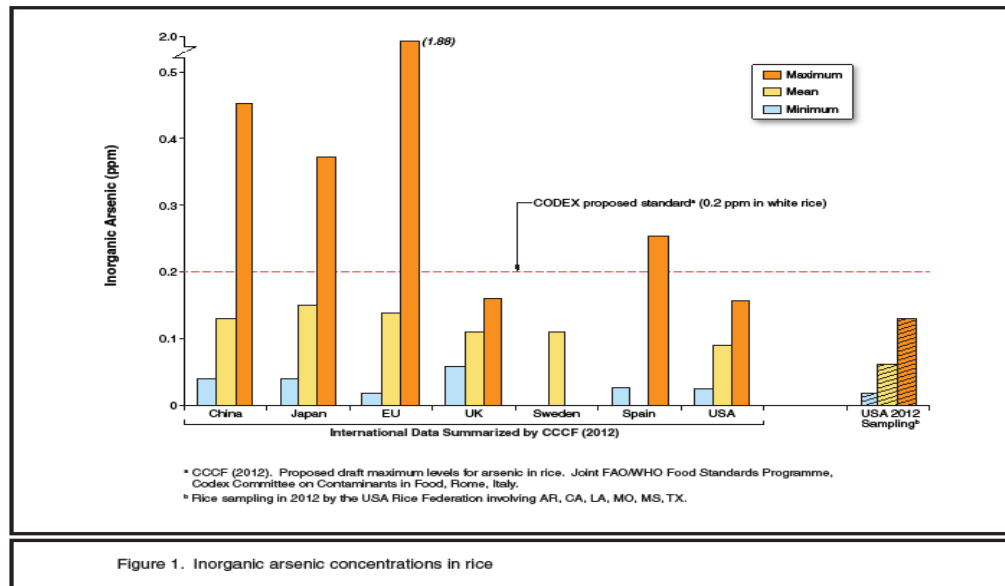
- Increased Risk of Cancers: Skin, Lung, Kidney, Liver, Bladder
- Alteration of many systems
→ adverse health effects
- 10% die with As related problem

Extrapolation from areas such as Bangladesh to areas with much lower soil levels of As (esp. as drinking water, cooking water, and all foods are sources of As) does not make logical sense

Tube-wells (n=2022) British Geological Survey
2022– As >50mg/l in 35% of wells
→300mg/l 8.4% of wells

ARSENIC IN RICE

- ▶ As content of U.S. rice is similar to that found in some regions of the world, but less than that reported to date in China, Japan, Australia, UK and the EU
- ▶ iAs in rice from California and the U.S. South is not materially different
- ▶ Levels of total As are different between regions





ARSENIC - MEDIA SCARES IN 2011 AND 2012 AND REASSURANCES IN 2013

DR. OZ – SEPT 2011, JAN 2012



Are High levels of
As in
foods dangerous?

**Dr. Oz Investigates:
As in Apple Juice**

**Dr. Oz Proves
This Fruit Juice
Can be Toxic**
January 22, 2012 | 289,193 views

APPLE JUICE & DRINKING WATER 2012

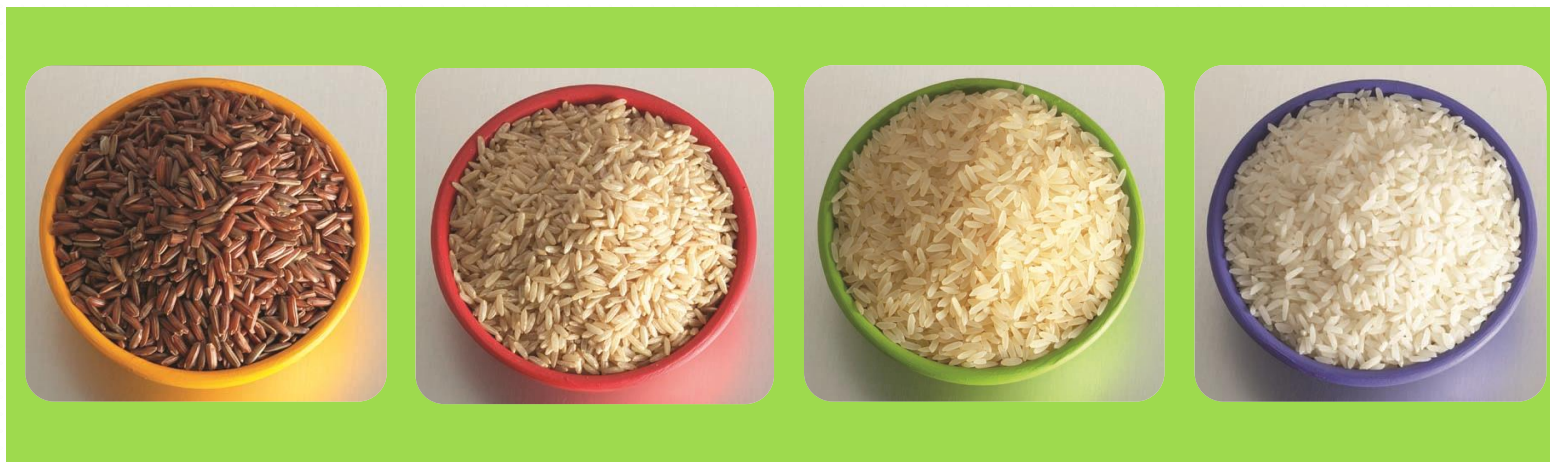
- ▶ 10 ppb the EPA drinking water standard
 - Use of drinking water standard for food & juice makes no sense, because consumers need 2 liters of H₂O/day and use it for cooking, preparing soups and beverages, cleaning food, bathing, etc.
- ▶ *Consumer Reports* study
- ▶ 10% of sampled juices As >10 ppb
 - (Later analysis does not substantiate)
 - Consumers Union calls for levels of 3 ppb - not attainable
- ▶ FDA Advice - Juice should be used in accordance with the Dietary Guidelines and can serve as one fruit serving

Expert • Independent • Nonprofit
ConsumerReports.org® Jan 2012



FDA TESTED more than 200 RICE PRODUCTS for iAs

▶ Sept 2012 findings



- ▶ Rice and rice products 3.5 to 6.7 $\mu\text{g}/\text{iAs}$ serving or measurement
- ▶ U.S. mean intake is ~ 2 c cooked rice/week or ~ 0.30 c cooked rice/day or $\sim 1\text{-}2$ μg iAs/day from rice
- ▶ Translates to a very small amount per week

- μg = microgram
- 1,000 micrograms = 1 milligram (mg)

ARSENIC - INFANT FOODS 2012

VARIETY and Moderation



- ▶ Children 1-2 yrs old eat ~7 g rice/day
→ 0.48 μg iAs/d
- ▶ Survey of children's products

“Relatively low concentrations of As ($< 1-23 \text{ ng g}^{-1}$) in formulas, purees and multiple ingredient infant foods...”

1-2 year old age group - 75 %ile exposure was $< 0.34 \mu\text{g}$ of inorganic As/day

Rice has high quality protein, is easy to digest and is non-allergenic, so it is offered as a first food

**FDA Commissioner Margaret Hamburg does not recommend changes by consumers (including children) regarding consumption of rice and rice products
Sept 2012**

FDA 2012 ADVICE TO THE PUBLIC

- ▶ “It is critical to not get ahead of the science...The FDA's ongoing data collection and other assessments will give us a solid scientific basis for determining what action levels and/or other steps are needed to reduce exposure to As in rice and rice products.” – *FDA Deputy Commissioner for Foods Michael Taylor*
- ▶ “Our advice right now is that consumers should continue to eat a balanced diet that includes a wide variety of grains – not only for good nutrition but also to minimize any potential consequences from consuming any one particular food.” – *FDA Commissioner Dr. Margaret Hamburg*

FDA ARSENIC: APPLE JUICE 2013



July 12, 2013 - “While the levels of As in apple juice are very low, the FDA is proposing an action level to help prevent public exposure to the occasional lots of apple juice with As levels above those permitted in drinking water.” – *FDA Deputy Commissioner for Foods Michael Taylor*

FDA data

94 samples of As in apple juice

95 % <10 ppb total As;

100 % <10 ppb iAs

FDA ASSESSMENT: ARSENIC IN RICE AND RICE PRODUCTS - SEPT 2013

▶ FDA tested >1,300 rices/rice products

- Including rice cakes and children's cereal
- As rice – 2.6-7.2µg/serving (sv)
 - ▶ Brown rice 160 ppb iAs/sv
 - ▶ Infant rice cereal had 120 ppb iAs/sv
 - ▶ Rice wine had 11 ppb/sv



▶ FDA: “As levels too low in rice to cause any immediate or short-term adverse health effects”

- ▶ <http://healthland.time.com/2013/09/09/fda-says-arsenic-levels-in-rice-are-safe-for-now/#ixzz2eQ9g6q1w>

- µg = microgram
- 1,000 micrograms = 1 milligram (mg)

FDA COMMISSIONER MARGARET HAMBURG

- ▶ **Sept 2013** - *“We don’t have all the answers yet, but we’re working on it. In collaboration with farmers, industry, academia and other public health agencies, we are doing everything possible to **determine if the levels of As in rice pose a long-term health risk** and, if so, what can be done to **reduce that risk**. The presence of As in rice is a global health issue. The answers we seek will ultimately help protect consumers all over the world.”* – FDA Commissioner Dr. Margaret Hamburg

www.fda.gov/ForConsumers/ConsumerUpdates/ucm352569.htm



THE AMERICAN ASSOCIATION OF PEDIATRICS SAYS

NEWS AND FEATURES

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Stephen R. Daniels, MD, PhD, chair of the American Academy of Pediatrics (AAP) Committee on Nutrition, said, "**These FDA data are reassuring.** While there is inorganic As in rice and rice products, **it is at a level that should be safe for consumption across the population.** Diets that follow the AAP guidelines include a variety of foods and a variety of grains and remain a healthful approach to eating for children and adolescents."

FDA ASSESSMENT – THE MEDIA REACTION

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FDA tests find very low levels of arsenic in rice

Elizabeth Weise, USA TODAY

The agency has found little cause for concern over levels of arsenic in rice and rice products.



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In tests for arsenic in more than 1,300 samples of rice and rice products, the Food and Drug Administration has found levels vary but overall are far too low to cause any immediate or short-term



FDA AND RICE INDUSTRY - RISK MITIGATION

- ▶ FDA Commissioner Margaret Hamburg and Deputy Commissioner Michael Taylor visited rice farms and test fields in Arkansas, California and Missouri to better understand how As is entering America's rice crops and the best ways to limit that exposure.



Rice Test Field



Commissioner Hamburg and
Deputy Commissioner Taylor



FDA Group



U.S. Food and Drug Administration
Protecting and Promoting *Your* Health

RICE INDUSTRY AND FDA COLLABORATION



Research underway on:

- Documenting the known health benefits of rice consumption in the U.S. and in populations around the world
- Determining impacts of agronomic practices and growing conditions on **As uptake** in rice
- Delineating differences in varieties as to **As content and accumulation**
- Effects of processing and milling on **As levels** in rice
- Rinsing study to determine effects on nutritive elements of rice vs. As removal
- Study: is there a threshold in the human body for As absorbed from the environment (i.e., below a certain level there is no adverse health effect)

This research will help inform next steps, which include:

- Human health risk from As exposure long term for all and for heavy rice consumers and vulnerable groups by the FDA
- Net risk/benefit analysis of rice consumption and health/nutrition impacts



FDA NEXT STEPS

► Risk Assessment

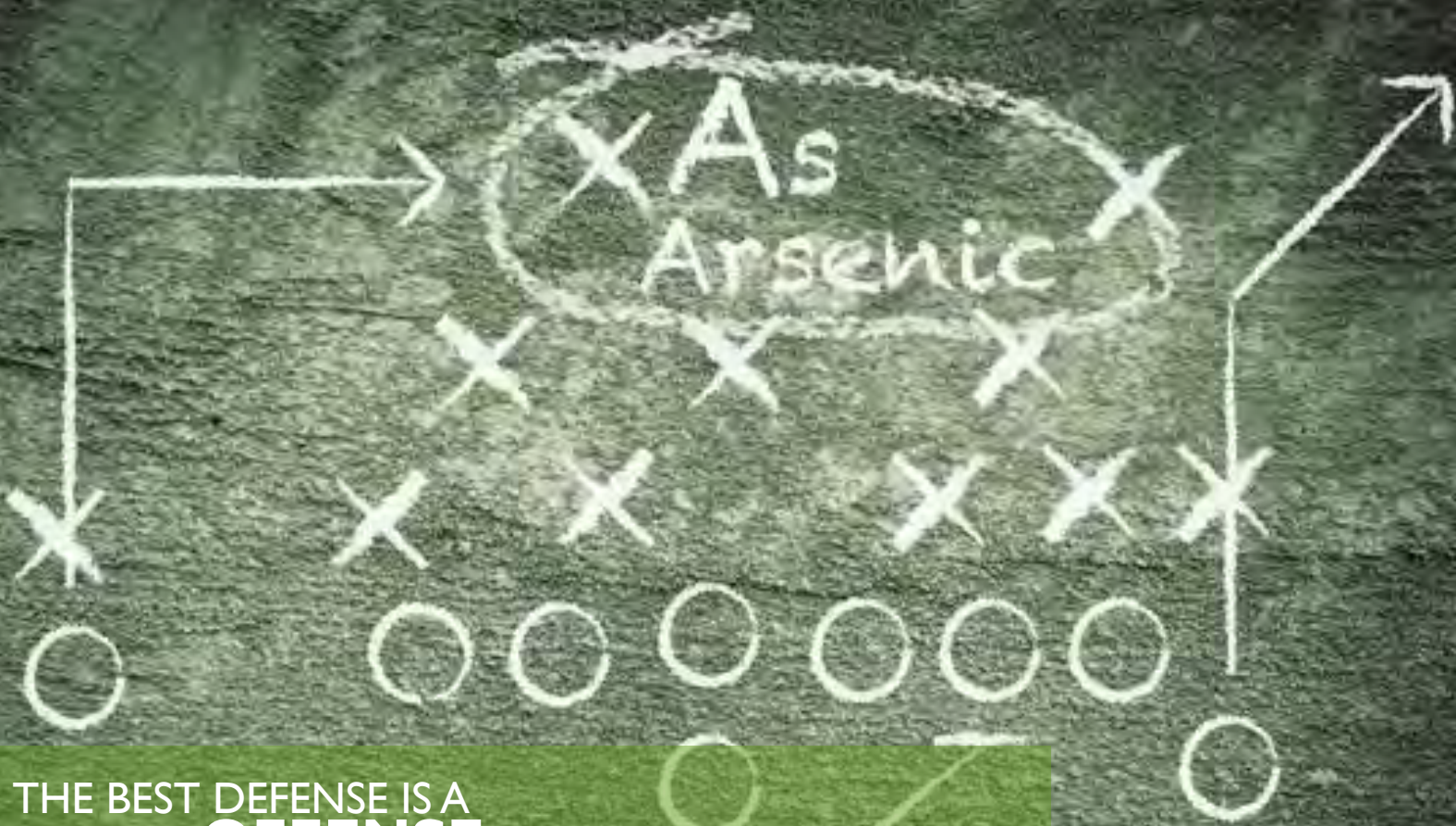
- Looking into any potential long-term risks
- *"To look at exposure levels, to analyze the risk, and determine how to minimize that risk for the overall safety of consumers, including vulnerable groups like children and pregnant women"*

► Additional Data Collection

- Longer term: study other juices and foods



Dr. Suzanne Fitzpatrick,
FDA

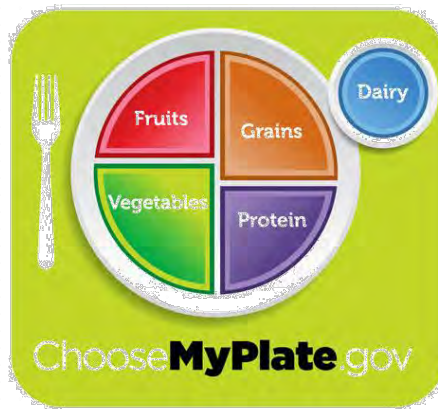


THE BEST DEFENSE IS A
STRONG **OFFENSE**

PROTECTING AGAINST ARSENIC

BEST PROTECTIVE STRATEGY IS A BALANCED DIET: INCLUDE PROTEIN, FIBER, FOLATE AND B12

- ▶ Focus on what we can do - consume a healthy diet
- ▶ Eat according to **MyPlate** - the best play in the dietary playbook



“Make half your grains whole”

BEST PROTECTIVE STRATEGY IS A BALANCED DIET: INCLUDE PROTEIN, FIBER, FOLATE, B12, SELENIUM

- ▶ **Ingesting adequate protein**, esp. those which are high in methionine (Met), helps to detoxify As
 - Meat, eggs, sesame seeds, Brazil nuts, fish and other plant seeds, including cereal grains
 - Vegetarians and vegans must balance low Met legumes with Met-containing grains
- ▶ **Ingest adequate dietary fiber** in whole grains and other foods; this inhibits the absorption of heavy metals
- ▶ **Ingest adequate B₁₂, folate and B vitamins**
 - One carbon transfers can be inhibited by As
- ▶ **Selenium ↓ oxidative stress from As (and other heavy metals)**
 - Sequesters As and makes it not available
 - ▶ 1 x 10⁹ people worldwide Se-deficient
 - ▶ Se supplementation may reduce the risk of some of some cancers – a possible link?



VITAMINS, PHYTONUTRIENTS AND ENZYMES TO PROTECT AGAINST ARSENIC OXIDATIVE STRESS

- ▶ Glutathione - sulfur amino acids/B vitamins
 - Folate (enriched rice and grains) and S-adenosylmethionine
- ▶ Vitamin C
- ▶ Vitamin E (α -tocopherol)
- ▶ Curcumin - turmeric
- ▶ Enzymes
 - Superoxide dismutase - Fe and Mn
 - Catalase (4 heme Fe/enzyme)



KNOWN HEALTH BENEFITS OF RICE

- ▶ Recent research shows that people who eat rice
 - Consume less sugar and saturated fat
 - Have a lower risk of high blood pressure and obesity
 - May be less likely to develop heart disease and type II diabetes
 - Consume more Fe, K, and dietary fiber – nutrients of concern
 - Consume more lean meat, vegetables and grains



ARSENIC - RICE

Average intakes of rice and As in U.S. and Japan

	Ave Rice intake g/d	iAs $\mu\text{g/d}$	Lifespan, yrs	Cancer Rate per 100,000
U.S.	15	0.98	78.8	125
Japan	400	27	82.2	115



OF RICE AND CVD MORTALITY

- ▶ Rice in Japan - **43%** of carbohydrate **29%** of E
- ▶ 83,752 Japanese men and women aged **40-79** y | 4.1 yr follow-up

▶ **Rice intake associated**

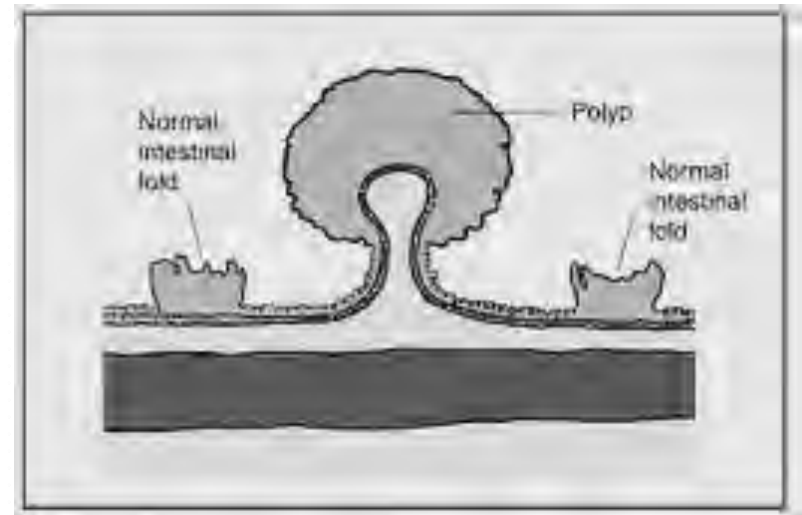
- ▶ **30%** decr. risk CHD and heart failure in men only
- ▶ **18%** decr. risk total CVD in men only
- ▶ **NO** association with risk of stroke in either gender



OF ARSENIC, CANCER AND BROWN RICE

Adventist Health Study I and 2

- ▶ 2,818 7th Day Adventist cohort subset with physician diagnosed polyps via colonoscopy
- ▶ Brown rice >1 sv/wk reduced polyp risk by **40%**
 - Relationship showed a dose response relationship
 - Polyphenolics (ferulates, oryzanol) – increased apoptosis and reduced cancer in cell culture
- ▶ Also decreased risk with green vegetables 3X/ wk and dried fruit 3X/wk



Tantamango YM, et al Nutr Cancer. 2011;63:565-72

Kong CK et al Biochem Pharmacol. 2009;77:1487-96

RICE BRAN AND BROWN RICE: PROTECTIVE AGAINST CANCER

- ▶ Rice bran - beneficial effects against several types of cancer
 - Breast, lung, liver and colorectal
- ▶ Polyphenolics, ferulic acid, tricin, β -sitosterol, γ -oryzanol, tocotrienols/tocopherols and phytic acid
 - Modulate the immune system
 - Inhibit cell proliferation
 - Alter cell cycle progression
 - Initiate the programmed cell death known as apoptosis in malignant cells
- ▶ Modulate gut microbiota metabolism

ELIMINATION OF RICE WON'T REMOVE EXPOSURE TO ARSENIC

- ▶ The best strategy is eating a wide variety of healthy foods on a regular basis
- ▶ **As is found in all foods**
 - Eliminating one or several foods will not solve the problem
 - Avoidance of a food group fails to consider the health benefits of these foods that are grown in the soil, such as fruits, vegetables and grains
 - Nutritional benefits of fruits, vegetables, grains and wine are documented, but low As risk is only theoretical



WHAT EXPERTS ARE SAYING

Concentrate on Risks We Know are Problems and We Can Change

- ▶ “The presence of a contaminant in food does not reliably indicate that eating the food is harmful...The health benefits of fish consumption seem to outweigh any harms from the mercury, at least in general. The health benefits of habitual intake of vegetables and fruits clearly outweigh any harms from the As they contain, or trace pesticide residues. Similarly, there is more As in brown rice than white, but the health benefits of eating a whole grain may outweigh that. And in general, although more rice intake seems to mean more As exposure, populations with the highest rice intake actually have lower, not higher, rates of cancer than ours in the U.S.” – *David Katz, MD, MPH, FACPM, FACP, founding Director of Yale University’s Prevention Research Center*
- ▶ “It’s unfair to single out one compound in food, especially when these foods contribute to a healthful diet overall. Research indicates individuals who consume foods like 100% fruit juice and rice actually have lower rates of cancer.” – *Keith-Thomas Ayoob, EdD, RD, FADA, Associate Clinical Professor of Pediatrics, Albert Einstein College of Medicine*

CONCLUSIONS

- ▶ Trace As uptake occurs naturally in plant foods, whether conventional or organically grown
- ▶ Levels of As in food have been monitored for >20 years and are not cause for concern
- ▶ The detection or mere presence of a small amount of toxicant or contaminant in a food does not necessarily mean a human health risk
- ▶ As levels in rice are many times lower than what is safely permitted for lifetime drinking water consumption
- ▶ FDA affirms that rice is not hazardous to human health in the short term and states there is no need to reduce consumption of rice
 - ▶ No need to reduce the consumption of rice among adults or children
- ▶ Elimination of any food group will not remove As

CONCLUSIONS

- ▶ No known adverse health effects from As in food and water in the U.S.
 - ▶ Populations with the highest rice intake have lower, not higher, rates of cancer and better health outcomes
- ▶ Focusing on the effects of a single toxicant fails to take into account net benefits of foods or the actual toxicity of the mineral within the food
- ▶ A healthy diet protects the body from contaminants, such as As and other naturally occurring toxins

ADDITIONAL RESOURCES

- ▶ U.S. FDA: [Apple Juice is Safe to Drink](#)
- ▶ U.S. FDA: [As in Food and Beverage](#)
- ▶ USA Rice: arsenicfacts.usarice.com
- ▶ IFIC Foundation: [“Questions and Answers about Arsenic in Food and Beverages”](#)
- ▶ U.S. FDA: [Statement on Arsenic in Brown Rice Syrup](#)