Health Benefits of Whole Grains and the Role of Intact Grains

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Funding from ILSI-North America
Scientific Advisor for the Whole Grains Council
All views expressed in this talk are my own
Outline

- What are whole grains?
- Why do we need whole grains in our diet?
- How much whole grain do we consume?
- How do they vary in nutrient composition?
- What do we know about whole grains & health?
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What is a Whole Grain?

- American Association of Cereal Chemists International (AACCI): "Whole grains shall consist of the intact, ground, cracked or flaked kernel (caryopsis), whose principal anatomical components – the starchy endosperm, germ and bran – are present in the same relative proportions as they exist in the intact caryopsis."

This definition means that 100% of the original kernel – all of the bran, germ, and endosperm – must be present to qualify as a whole grain.

http://www.aaccnet.org/definitions/wholegrain.asp
Whole Grain Kernel is Nutrient Dense

Brouns et al. (2013); Surget & Barron (2005)
Effects of Grain Milling (i.e., removal of the bran and germ)

<table>
<thead>
<tr>
<th>Whole vs. Refined Grain Wheat Flour</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>↓ 14%</td>
</tr>
<tr>
<td>Fiber</td>
<td>↓ 83%</td>
</tr>
<tr>
<td>Magnesium</td>
<td>↓ 81%</td>
</tr>
<tr>
<td>Manganese</td>
<td>↓ 75%</td>
</tr>
<tr>
<td>Potassium</td>
<td>↓ 75%</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>↓ 95%</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>↓ 87%</td>
</tr>
<tr>
<td>Folate</td>
<td>↑ 250%*</td>
</tr>
<tr>
<td>Thiamine</td>
<td>↑ 80%*</td>
</tr>
<tr>
<td>Iron</td>
<td>↑ 10%*</td>
</tr>
</tbody>
</table>

*Increased due to enrichment of cereal grain products
True Grains
(Poaceae or Gramineous family)

- Wheat
  - Spelt
  - Farro
  - Kamut
  - Einkorn
- Oats
- Brown Rice
- Corn (maize, popcorn)
- Barley (hulled)
- Rye
- Canary Seed

- Millet
- Wild rice
- Triticale
- Sorghum
- Teff
- Fonio
- Job’s Tears

Gluten Free
Pseudocereal Grains

“...are not botanically true grains but are typically associated with the grain family due to their similar composition”

- Amaranth*
- Buckwheat*
- Quinoa*

* Gluten Free
## Eat a Variety of Grains

<table>
<thead>
<tr>
<th>Grain</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Oats ***</td>
<td>High in β-glucans&lt;br&gt;Rich in mono- and pufa acids, oligosaccharides, plant sterols and other phytochemicals&lt;br&gt;Excellent source of magnesium, phosphorus, manganese&lt;br&gt;&lt;i&gt;Linked to lower risk of CVD risk factors&lt;/i&gt;</td>
</tr>
<tr>
<td><strong>Kamut / Khorasan wheat</strong></td>
<td>Higher in protein compare to other wheats&lt;br&gt;Excellent source of selenium and zinc&lt;br&gt;&lt;i&gt;Lower lipids/reduce inflammation&lt;/i&gt;</td>
</tr>
<tr>
<td><strong>Rye</strong></td>
<td>High in fiber, high antioxidant activity&lt;br&gt;Rich in bioactive compounds&lt;br&gt;&lt;i&gt;Linked to lower risk of CVD risk factors&lt;/i&gt;</td>
</tr>
<tr>
<td><strong>Barley</strong></td>
<td>Soluble fiber β-glucan&lt;br&gt;&lt;i&gt;Linked to lower risk of CVD risk factors&lt;/i&gt;</td>
</tr>
</tbody>
</table>

* Gluten Free
Ancient Grains Are Making a Comeback

- Grains that have survived intact for centuries and are not altered by modern plant science breeding practices

- 44% of adults reported eating an ancient grain in the past 3 months


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## Ancient Grains

<table>
<thead>
<tr>
<th>Grain *</th>
<th>Description</th>
<th>Nutritional Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amaranth</strong></td>
<td>Staple grain of the Aztecs, eat toasted or puffed as cereal</td>
<td>High in phytosterols (cholesterol lowering properties); Mineral rich (high in calcium, iron, magnesium, phosphorus, and potassium); Excellent protein source</td>
</tr>
<tr>
<td><strong>Quinoa</strong></td>
<td>Cultivated in pre-Columbian Andes region. Eat as a grain dish like rice</td>
<td>Complete protein source (lysine and isoleucine) High in MUFAs Mineral rich</td>
</tr>
<tr>
<td><strong>Buckwheat</strong></td>
<td>Used as a breakfast grain, in soba noodles, or in cold salad</td>
<td>Good source of magnesium and fiber Excellent protein source Lower glycemic index Prebiotic-like benefits?</td>
</tr>
<tr>
<td><strong>Teff</strong></td>
<td>Ethiopian injera bread, often used as a gluten-free four</td>
<td>Calcium (1 cup=123 mg) High in vitamin C Resistant starch, iron</td>
</tr>
</tbody>
</table>
## Health Benefits of Whole Grains

<table>
<thead>
<tr>
<th></th>
<th>Cardiovascular Disease</th>
<th>Type 2 Diabetes</th>
<th>Colorectal Cancer</th>
<th>Blood Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>~21% ↓</strong></td>
<td>~26% ↓</td>
<td>17% ↓</td>
<td>23% ↓</td>
<td></td>
</tr>
</tbody>
</table>

Whole Grains and Chronic Disease Reduction: Potential Mechanism

(Viscosity/food structure)

Whole grain intake ↑

Dietary fiber ↑

Colonic fermentation ↑

Bioactive components ↑

Whole Grains and Chronic Disease Reduction: Potential Mechanism

(Viscosity/food structure)

Whole grain intake ↑

Dietary fiber ↑

Colonic fermentation ↑

Bioactive components ↑

Insulin sensitivity ↑

Homocysteine ↓

Antioxidant/anti-inflammatory status ↑

Blood lipids ↓

Type 2 diabetes ↓

Cardiovascular diseases ↓

Cancer ↓

GI ↓ and or II ↓

Satiety ↑

Obesity ↓

(Betaine)

Tumour growth ↓

Whole grains provide **dietary fiber, oligofructose and resistant starch** that are available to the gut microbes (↑ bifidobacteria)

- ↑ Fecal Bulk
- ↑ Transit time
- ↑ SCFA production (butyrate)
- ↓ pH
- Modulation of immunity
- Modulation of inflammation
- Enhance the bioavailability and uptake of minerals (Ca, Mg, Fe)

**Let’s not starve our Microbes!**
“...all adults eat at least half their grains as whole grains – that's at least 3 to 5 servings of whole grain”
Easy to Achieve

- 1/2 cup cooked oatmeal
- 1/2 cup cooked 100% whole-grain pasta
- 1/2 cup cooked brown rice or whole-grain barley or any other cooked whole grain
- 1 regular slice of 100% whole-grain bread
- 1 cup of whole-grain ready-to-eat cereal (flakes or rounds) or 1 1/4 cup puffed

Yet most people are not consuming enough whole grains!
## Whole Grain Consumption NHANES 2009-10

(Reicks et al Nutr Res. 2014;34:226)

<table>
<thead>
<tr>
<th></th>
<th>None (0)</th>
<th>Low (&gt;0-&lt;3)</th>
<th>High (≥3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Children/adolescents</strong></td>
<td>n = 1321</td>
<td>n = 1720</td>
<td>n = 83</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>0.0</td>
<td>0.79</td>
<td>3.99</td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>38.8</td>
<td>58.3</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Adults</strong></td>
<td>n = 2677</td>
<td>n = 2853</td>
<td>n = 388</td>
</tr>
<tr>
<td><strong>Mean ± SE</strong></td>
<td>0.0</td>
<td>0.96</td>
<td>4.38</td>
</tr>
<tr>
<td><strong>Percentage</strong></td>
<td>41.9</td>
<td>50.4</td>
<td>7.7</td>
</tr>
</tbody>
</table>

*Ounce equivalent serving size: 1/2 cup cooked brown rice, hot cereal, such as oatmeal or other cooked grain; 1 slice 100% whole grain bread; 1 cup 100% whole grain ready-to-eat cereal.
Whole Grain Food Sources - NHANES 2009-10
(Reicks et al Nutr Res. 2014;34:226)
Increase Consumer Awareness of Differences Between Intact (minimally processed) versus Processed Whole Grains

“How are you not seeing this? Of course doughnuts are a hole food!”
Eat more Whole Grains that Are Intact (Natural) Grains (i.e. Minimally Processed)

- Unmilled and intact grains provide nutrient-rich fibers, nutrients, and phytochemicals but also **provide benefits attributable to their physical form**
- Evidence suggests that the **physical form** of undigested food particles may be more important (than either the fermentation or water-holding capacity of fiber) in **controlling stool bulk**
- **Intact seeds** prevents the digestive enzymes from reaching the nutrient-rich germ and starchy endosperm which helps **deliver substrates to the gut for bacteria fermentation**

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Eat more Whole Grains that Are Intact (Natural) Grains (i.e. Minimally Processed)

- Controlled metabolic studies on whole grain wheat showed that breads including whole kernels increased satiety more than breads made with whole grain flour.

- Preservation of the intact botanical structure of cereal grains has been shown to lower the insulin response

Heaton et al (1988); Holm et al (1992); Hiebowicz et al. 2008
Outline

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- How much whole grain do we consume?
- How do they vary in nutrient composition?
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Abdominal Obesity: The Critical Adipose Depot

METABOLIC SYNDROME

Men: >40 inches
Women: >35 inches

↑ Dyslipidemic
↑ Blood Pressure
↑ Inflammation
↑ Insulin resistance

People Who Eat More Whole Grains Gain Less Weight

Annualized Weight Change (kg)

Whole Grain Intake (gm/day)

Normal weight ($P_{\text{trend}} < 0.001$)

Overweight/obese ($P_{\text{trend}} = 0.83$)
People Who Eat More Whole Grains Have Less Visceral Abdominal Fat

Mean multivariate-adjusted* VAT by whole and refined intake quintile categories

McKeown et al. AJCN 2010 Nov;92(5):1165-71

*adjusted for age, sex, smoking status, total energy, alcohol intake, SAT
Substitute Whole Grains for Refined Grains for Lower VAT

McKeown et al. AJCN 2010 Nov;92(5):1165-71
“Based on the available evidence, we conclude that whole-wheat consumption cannot be linked to increased prevalence of obesity in the general population”

OBESITY HAS A MULTIFACTORIAL CAUSATION
The Balance Between Unhealthy & Healthy Carbohydrates: The Scales Have Been Tipped

Dietary Fiber
38 grams for men
25 grams for women
Average intake is 15g/d

Added Sugars
100 to 150 calories per day
- 25% or less of calories
Average intake is ~350 kcal/d

Whole Grains
3 or more servings/d
Average intake is 1 serving

Refined grains
Average intake is 3 serving

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Dietary Advice on Whole Grains

- Gluten free does not mean grain free
  Amaranth, buckwheat, corn, millet, most oats, quinoa, rice, sorghum, teff, wild rice
- Replace refined grains with whole-grains
- Eat a variety of whole grains
- Try to incorporate intact grains into your diet!