Sorghum: Nutrition Attributes and Health Benefits Research Update

Nancy D. Turner
Associate Professor of Nutrition, Food Science and Genetics
Texas A&M University, College Station
U.S. Chronic Disease Challenges

- Large chronic disease problem
  - >26 million with Heart Disease, >610,000 deaths
  - >29 million with Diabetes
  - 1,660,290 new Cancer diagnoses each year, >580,000 deaths
    - 142,820 colorectal cancer cases, > 50,000 deaths
  - 1.4 million with Inflammatory Bowel Disease
  - In excess of 2 million suffer from Celiac Disease

CDC, 2013, 2014; ACS, 2013
Obesity Trends* Among U.S. Adults

(*BMI ≥30, or about 30 lbs. overweight for 5’ 4” person)

<table>
<thead>
<tr>
<th>Year</th>
<th>No Data</th>
<th>&lt;10%</th>
<th>10%–14%</th>
<th>15%–19%</th>
<th>20%–24%</th>
<th>25%–29%</th>
<th>≥30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td></td>
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<td></td>
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<td></td>
</tr>
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<td>2000</td>
<td></td>
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<td>2010</td>
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</table>

Source: Behavioral Risk Factor Surveillance System, CDC.
Economic and Public Policy Challenges

• 75% of the national health care expenditures

• National goal is to “avoid preventable diseases from occurring in the first place”.
  • Target - Double whole grain consumption

• Which grains should be targeted to get the most benefit?
Could Sorghum Help?

- Multiple varieties exist
  - Exhibit varying colors
  - Contain several biologically active phytochemicals
  - Many reach the colon
- May impact
  - Colon health
  - Intestinal bacteria and metabolism
  - Systemic metabolism
Option for Celiac Patients

- Nutritional profile is beneficial
  - Fiber, micronutrients
- Multiple cookbooks available
  - Carol Fenster
## Antioxidant Activity

<table>
<thead>
<tr>
<th>Food</th>
<th>ORAC activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>White sorghum grain</td>
<td>22</td>
</tr>
<tr>
<td>White sorghum bran</td>
<td>64</td>
</tr>
<tr>
<td>Black sorghum grain</td>
<td>219</td>
</tr>
<tr>
<td>Black sorghum bran</td>
<td>1008</td>
</tr>
<tr>
<td>Tannin sorghum grain</td>
<td>868</td>
</tr>
<tr>
<td>Tannin sorghum bran</td>
<td>3124</td>
</tr>
<tr>
<td>Red apple</td>
<td>295</td>
</tr>
<tr>
<td>Blueberries</td>
<td>842</td>
</tr>
</tbody>
</table>

Dykes and Rooney, CFW 2007
Resistant Starch Formation

- Pure starch after cooking
  - Control or extracts from white, black or tannin-containing sorghum
- Enhances slowly digestible starch content

![Graph showing Resistant Starch (%)]

Barros, 2011 AACC
Cholesterol Metabolism

Grain Sorghum Lipid Extract Reduces Cholesterol Absorption and Plasma Non-HDL Cholesterol Concentration in Hamsters¹,²

Timothy P. Carr,³ Curtis L. Weller,†** Vicki L. Schlegel,** Susan L. Cuppett,** David M. Guderian, Jr.,* and Kyle R. Johnson*

Departments of *Nutrition and Health Sciences, †Biological Systems Engineering, and **Food Science and Technology, University of Nebraska, Lincoln, NE

- LDL cholesterol promotes CVD and HDL cholesterol is protective
- Lipids extracted from sorghum improved both LDL levels (reduced) and HDL levels (increased)
Colon Disease in the U.S.

- Large intestine disease\(^1\)
  - 142,672 colon cancer cases, > 53,000 deaths
  - 1.4 million with IBD
  - Chronic IBD patients are at a greatly increased risk of developing colon cancer
- Aging population is predicted to cause increased rates
  - Colon cancer rates increase 52% by 2030\(^2\)

\(^1\) CDC, 2011; \(^2\) Harris et al. 2009 J. Clin. Oncol. 27:2758
Polyphenol-Enriched Brans Suppress Aberrant Crypts

Turner et al. (Cereal Chemistry)
AC Inhibition vs Antioxidant Activity

- Elevations in diet antioxidant activity contributes strongly to reduction in AC formation
- Compounds generating antioxidant activity are producing the protection

Turner et al. (Cereal Chemistry)
Functional Changes in Microbial Populations

Turner et al. (Cereal Chemistry)
Intestinal Microbiota and IBD

• Intestinal bacterial populations (dysbiosis) are tied to development and severity of colitis
• Recurrent colitis is a promoter of colon cancer
Relationship Between Inflammatory Stimulus and Injury

- Black and Sumac sorghum reduced activation of an inflammatory mediator (NF-κB) and resulting injury scores

Ritchie et al. (In Preparation)
Colon Microbial Differences

- Distinct diet patterns

Ritchie, Azcarate-Peril, and Turner, In Preparation
Diet and Obesity

• Obese subjects have altered microbiota, relative to lean individuals
• Obesity promotes colon carcinogenesis, heart disease and diabetes
• Can dietary bioactive compounds impact bacteria in overweight subjects in a way that beneficially alters human metabolism?
Low plasma levels associated with glucose intolerance (Zhao et al., Metab. 2010)

Anti-inflammatory (Sokol et al., PNAS, 2008)

Seidel et al. – FASEB J, 2014

Sumac sorghum breakfast cereal
Conclusions/Implications

• Sorghum grain and their bioactive phytochemicals appear to contribute toward the suppression of several chronic diseases

• National goal is to “avoid preventable diseases from occurring in the first place”.
  • Target - Double whole grain consumption

• Sorghum should be included in our food supply to derive these health benefits
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