Health benefits of wholegrain: an intervention study to clarify underlying mechanisms and the role of polyphenols bound to dietary fiber

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Cereal dietary fibre: a natural functional ingredient to deliver phenolic compounds into the gut

Paola Vitaglione, Aurora Napolitano and Vincenzo Fogliano*
Physiological relevance

1 - Along the gastro intestinal tract

• It can act as a “sponge” quenching the radicals which are formed

• Not only the traditional “mechanical” effect, but also the chemical activity

• Prebiotic activity (typical of cereal arabinoxylans)
Physiological relevance
2 - Through a systemic effect

- Polyphenols bound to DF are slowly and continuously released from the gut into the bloodstream triggering anti-inflammatory response
These hypotheses were tested in an intervention study with wholegrain wheat in overweight/obese subjects.
Our approach...

• Selection of a commercial WG product with the highest amount of polyphenols bound to dietary fiber

• A two-month treatment in overweight/obese subjects replacing refined wheat products with WG in their habitual diet
<table>
<thead>
<tr>
<th>Target</th>
<th>What measure</th>
<th>Where</th>
<th>How</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant status</td>
<td>• Phenolic acids linked to gut metabolism (ferulic acid, dihydroferulic acid, etc)</td>
<td>• Serum</td>
<td>• LC-MS/MS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Urine</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Feces</td>
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<tr>
<td>Weight management</td>
<td>• Weight</td>
<td>Body</td>
<td>• Balance</td>
</tr>
<tr>
<td></td>
<td>• Circumferences</td>
<td></td>
<td>• Meter</td>
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<tr>
<td></td>
<td>• Bioimpedance</td>
<td></td>
<td>• BImeter</td>
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<tr>
<td>Inflammation</td>
<td><strong>Cytokines (IL-6, TNF-α, IL-10, IL-4...)</strong></td>
<td>Serum</td>
<td>Multiplexed assays (BioPlex)</td>
</tr>
<tr>
<td>Diabetes and CVD risk</td>
<td>• Glycaemia</td>
<td>Blood</td>
<td>• Fingertip glucometer</td>
</tr>
<tr>
<td></td>
<td>• Blood lipids</td>
<td>Plasma</td>
<td>• BioPlex (Luminex)</td>
</tr>
<tr>
<td></td>
<td>• Glucose metabolism hormones (insulin, GLP-1, GIP, adiponectin, PAI-1,...)</td>
<td>Serum</td>
<td></td>
</tr>
<tr>
<td>Gut health</td>
<td><strong>Microbiota composition</strong></td>
<td>Feces</td>
<td>Metagenomic analysis</td>
</tr>
</tbody>
</table>
Conclusions

- Ferulic acid is bioavailable from WG and can influence inflammatory status
- This finding is independent from a prebiotic activity of WG
Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease\textsuperscript{1–4}.

Susan S Cho,\textsuperscript{5} Lu Qi,\textsuperscript{6} George C Fahey Jr,\textsuperscript{7} and David M Klurfeld\textsuperscript{8*}

**TABLE 11**

<table>
<thead>
<tr>
<th></th>
<th>T2D</th>
<th>Obesity</th>
<th>CVD</th>
<th>Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal fiber</td>
<td>B</td>
<td>B/C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Mixtures of whole grains and bran</td>
<td>B</td>
<td>B/C</td>
<td>B</td>
<td>D</td>
</tr>
<tr>
<td>Whole grains</td>
<td>C</td>
<td>C/D</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

\textsuperscript{1} CVD, cardiovascular disease; T2D, type 2 diabetes.

In general it seems that cereal bran consumption may increase health benefits of WG consumption!
• The comparison among the studies is a hard task
• Different wholegrain products / Different cereal bran ➔ different amount of DF and polyphenols bound to dietary fiber

different effects through different mechanisms!
For the future to better clarify underlying mechanisms

- To design intervention studies including:
  - strictly selected subjects by specific criteria (Habitual diets? Physical activity level? BMI? Healthy/Patients? A specific microbiota composition?)
  - one WG product or precise combination of some (to let subjects choose in a basket of products may mean to have completely different cereal DF and polyphenol intake among subjects ➔ difficult to understand what makes what!)
Acknowledgements

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• PhD and students who were involved in my WG team
• Prof Vincenzo Fogliano with whom the whole study was shared
Thank you for your attention!
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**Whole-grain wheat breakfast cereal has a prebiotic effect on the human gut microbiota: a double-blind, placebo-controlled, crossover study**

Adele Costabile¹*, Annett Klinder¹, Francesca Fava¹, Aurora Napolitano², Vincenzo Fogliano², Clare Leonard³, Glenn R. Gibson¹ and Kieran M. Tuohy¹


**Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease¹–⁴**

Susan S Cho⁵, Lu Qi⁶, George C Fahey Jr⁷ and David M Klurfeld⁸*