Ancient, ancestral, heritage, and modern... the whole nine grains...

Dr. Andrew Ross
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Disclosures

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Ancient, ancestral, heritage, pseudo, and modern: the whole nine grains...

Andrew Ross
Oregon State University
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- Cereal Quality Lab Operating: Oregon Wheat Commission
- Acrylamide potential in Oregon soft wheats: Oregon Wheat Commission
- Measuring amylases and their effects in wheat: USDA
- Whole grain naked barley for food: USDA AFRI OREI

- Research Bakery Rebuild
  - OSU College of Agricultural Sciences (CAS) Building Use Credits
  - American Rescue Plan Act
  - Oregon Wheat Commission
  - Fax Family Endowment
  - Bay State Milling
  - Wheat Marketing Center
  - OSU Dept. of Crop and Soil Science
  - Hatch Funds - Plant Breeding and Genetics Project (shelving)
Cormac McCarthy’s three things

• Wholegrains are good for you.

• Wholegrains are superior nutritionally to refined grains.

• Eat a diverse array of wholegrains - ancient, ancestral, heritage, pseudo, or modern to help maintain your gut microbe diversity.

Wholegrains and health

*“[Less than] 5% of Americans meet the recommended intake for dietary fiber, and the magnitude of the gap is large, approximately a 50–70% shortfall…

…the fiber gap represents an opportune target at which dietary interventions can be directed”.

Why whole grains

• Superior contributions to human wellbeing.
  • A convenient and synergistic way of addressing the fiber gap.
  • Contribute big MACs and therefore colonic SFCAs.

• Habitual consumption of whole grains:
  • Increased longevity
  • Increased active lifespan
  • Reduced incidence of cardiovascular diseases, Type 2 Diabetes, & colorectal cancers.
  • Improved gut health
  • Improved microbiome health and diversity.
  • Fecal regularity

Delaying the onset of senescence...

• “…improving life expectancy is not enough…

• [only improving life expectancy] predicts in current circumstances [just] an increased number of years in poor health”.

• “[Ellison et al's] An intervention* that delays ageing such that life expectancy increases by one year (and health improves too) is worth $38 trillion [each year]…” in the USA alone.

*metformin

All's well that ages well: The economic value of targeting ageing. Martin Ellison, Andrew Scott, David A. Sinclair 11 August 2021.
https://voxeu.org/article/economic-value-targeting-ageing
Common fiber types in cereal grains.

- Arabinoxylans and xylo-oligosaccharides
- Beta glucan
- Fructans and fructo-oligosaccharides
- Galctooligosaccharides
- Resistant starch

These are often microbiota accessible carbohydrates (big MACs). Soluble OR insoluble forms.


Quinoa, amaranth, buckwheat

Fiber polysaccharides of the dicot pseudocereals are rich in pectins and xyloglucans.

The polysaccharide composition[s] of the 3 pseudocereal grains are more like fruits and vegetables than they are like cereals.


Micronutrients are commonly co-located with the fiber and may be the key difference between eating the whole grain, as opposed to refined fiber fractions:

FIBER: direct effects
Soluble fiber: direct effects

viscosity and glycemia

viscosity and cholesterolemia

Figure 3 Relationship between glycemic responses of human subjects (AUC of the postprandial blood glucose curve) and the apparent viscosity (at 30 mPa·s) of the β-glucan extracted by simulated digestion. AUC = −25 log(η) + 134 (r² = 0.85). Adapted from Tosh (2013).26 Abbreviations: AUC, area under the curve.

Insoluble fiber: direct effects

Insoluble fiber...
- promotes regularity
- increases colonic transit speed via irritation of gut mucosa and stimulation of peristalsis. Increases stool frequency.

"Large, coarse particles providing greater laxative efficacy than fine, smooth particles".

Soluble fiber also increases fecal bulk and water content – increases fecal bacterial count, increases stool frequency but can induce bloating and gas retention.


SCFA: Short chain fatty acids

“Production of short-chain fatty acids (SCFAs), especially butyrate, in the gut microbiome is required for optimal health but is frequently limited by the lack of fermentable fiber in the diet”.

Effects attributed to increased microbial SCFA formation: GUT HEALTH

• improved gut barrier function
• reduced intestinal inflammation.
• butyrate is an [the] important fuel for the colonocytes.
• increased mucus production from epithelial goblet cells

Effects attributed to increased microbial SCFA formation: **SYSTEMIC HEALTH**

- reduced incidence of obesity
- reduced T2 diabetes - via effects on body weight control, and energy intake and expenditure, added to the direct effect of reducing glucose absorption rate
- increased insulin sensitivity
- reduced systemic low-grade inflammation


A Low-Fiber Diet is a Key Driver of Microbiome Depletion

“It is likely that a combination of factors (antibiotics, modern clinical practices, sanitation, dietary habits) have caused the decline in gut microbiome diversity.

…The only factor that has been empirically shown to be important [in reducing microbiome diversity] is a diet low in microbiota-accessible carbohydrates (MACs)”. 
Eat a diverse array of whole grains and pseudograins...

“The different assortments of enzymatic machineries in different microbial species results in specialization for fermenting specific fiber types”.


Ask not just what can you do for whole grains – but ask what can they do for you!

Cycling to work since 1998

As of Sept 20 2023 this bike: = 25,632 km (nearly 16,000 miles) since Nov 23 2018

April 2018
2022: 51 years in the water
Sept 17 2023 – 53 years in the water - 66 years and 13 days

IG @wholegrainsurfer
Another element of my own experience with wholegrains and health – Wow! – says my primary care physician. Updated with 2022 results

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<th>Lipid Panel 11/18/2020 (#14037175, Final, 11/18/2020 8:43am)</th>
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<td><strong>Lipid Panel</strong></td>
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<td><strong>HDL</strong></td>
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11/2022

*Most healthcare providers want the ratio to be below 5:1. A ratio below 3.5:1 is considered very good.*

https://www.urmc.rochester.edu/encyclopedia
Ancient, ancestral, heritage and recent wheats

Emmer [left], einkorn [right]
Foto: Prof. Friedrich Longin
Universität Hohenheim
Gluten sensitivity and celiac disease: Is gluten changing in “modern” versus “old” wheats

Gluten content

Wheat…

Fernando et al. 2012 showed a 12.7% decrease in protein (~1% in absolute concentration) at 550 ppm* CO₂ and decreases in S, Ca, Fe, and Zn contents.

…reductions in nitrogen and minerals were not fully explained by biomass dilution.


*around 2050 according to https://www.yaleclimateconnections.org/
Gluten sensitivity: Is the gluten changing: “modern” versus “old” wheats

The alpha-gliadin 33-mer (p 56-88)


“…the effect of different harvest years is much more important compared to the genetic effect, because we identified both old and modern cultivars containing high and low contents of CD-active peptides, respectively”.

Proportions [%] of 33-mer based on α-gliadin contents in five cultivars per decade averaged over three harvest years 2015–2017 (D). Boxes represent the interquartile range with the median (line in the box) and mean (point in the box) and whiskers represent the minima and maxima. Different capital letters designate significant differences between the decades (one-way ANOVA, Tukey’s test, p < 0.05).

**Figure 3** Ancient wheats contain more gluten. Total protein (left) and gluten content in bread wheat, spelt, durum wheat, emmer and einkorn (n = 15 cultivars grown at four locations (n = 60) in Germany). Modified with courtesy from Geisslitz et al. (2019)


- “Example of a selected gliadin derived peptide (so-called p. 31–49), which was higher in ‘ancient’ wheat (Khorasan), compared to modern durum wheat (cultivar Cappelli). Figure kindly supplied by A. Gregorini, based on Gregorini et al. (2009).”

Suter, D.A. and Békés, F., 2020. Who is to blame for the increasing prevalence of dietary sensitivity to wheat?. *Cereal Research Communications*, pp.1-19.

**Fig. 1** Values reported in the literature within and among wheat types for **a** celiac reactivity, **b** human α-amylase inhibitor (ATI) activity, **c** allergenicity, and **d** fructan content. Horizontal lines indicate the median value for each of the value ranges. Modern wheat includes varieties of common wheat that were developed after 1950, while heritage wheat includes varieties and landraces that were developed before 1950.
Einkorn

• “Our study shows that [einkorn] is toxic for CD patients as judged on histological and serological criteria, but it was well tolerated by the majority of patients, suggesting that [einkorn] is not safe for celiacs, but that it may be of value for patients with gluten sensitivity or for prevention of CD”.


• n: 7, m/f: 1/6, Age: 37±7.3 yrs.
• BMI: 22.8±3.1
• Celiac disease in remission for 1 yr. on GFD
• Total duration 60-day intervention trial
• Triticum monococcum (Einkorn) wheat (100 g/day) in the [form] of water biscuits
**FODMAPs**

- Fermentable oligo-, di-, and monosaccharides and polyols*

  *e.g., sorbitol, xylitol

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**Inulin**

A fructo-oligosaccharide.


**Galactoses**

\( n = 2 \) – stachyose
\( n = 1 \) – raffinose

**a galacto-oligosaccharide**

**Lactose**

Disaccharide

**Fructose**

Monosaccharide

**Polyol**

D-Glucitol (sorbitol)
FODMAPs and ancestral wheats

Fructans and fermentation

Mannitol


“Digestibility” and fermentation

• Enhanced protein digestibility
• Retarded starch digestibility
Are ancestral wheats (and rye and barley) enriched in specific nutritional components vs recent hexaploid wheats?
TDF

• Reported contents of total dietary fiber in ancient and modern wheat species.


• Lower levels of TDF in emmer are disputed with evidence, in the review by Čurná, V. and Lacko-Bartošová, M., 2017. Chemical composition and nutritional value of emmer wheat (Triticum dicoccon schrank): A review. *Journal of Central European Agriculture*. 
A – Distribution of estimated dietary fibre

B – Distribution of β-glucan

Adapted from Table 3 - Shewry, P.R. and Hey, S., 2015. Do “ancient” wheat species differ from modern bread wheat in their contents of bioactive components?. *Journal of Cereal Science*, 65, pp.236-243.
Minerals in general

• “10 emmer and ten spelt accessions vs 2 common wheats and 3 durums, 1 location.

• Emmer and spelt wheat differed from common and durum wheat cultivars in having higher levels of lithium, magnesium, phosphorus, selenium, and zinc.

• The highest levels for all minerals tested were found in spelt accessions.

• Ash content in emmer was usually higher (>2.0% db) than in durum and common wheat (1.7 – 1.8% db).

• The low ash content of modern wheat cultivars is the result of selection…”.

The effect of CO$_2$ on individual chemical elements in plants. Change (%) in the mean concentration of chemical elements in plants grown in elevated CO$_2$ relative to those grown at ambient levels. C3 plants. Average ambient and elevated CO$_2$ levels are 368 ppm and 689* ppm respectively.

The results reflect plant data (foliar and edible tissues, FACE and non-FACE studies) from four continents.


*2070 to 2075 according to https://www.yaleclimateconnections.org/


Fe$^{2+}$ Zn$^{2+}$
Phytic acid/phytate, fermentation, mineral availability

Cis to trans conversion

# A linoleic acid peroxyl-radical
Some things I have not addressed...

- Genetic diversity
- Deep roots and soil health
- Climate resilience
- Dietary diversity
- Peas, beans, lentils
- Fun…
100% wholegrain **spelt** sourdough bread

flour
water
salt
microbes