

Developments in the Wheat Industry: Tackling Wheat Digestibility



auri

Agricultural
Utilization
Research
Institute

**MNIFT Virtual Luncheon
Webinar**

May 19, 2021

12 pm - 1:15 pm

AURI Programs and Resources Overview

- ▶ Agricultural innovation from idea to reality.

**We will
have a
Moderated
Panel/Q&A
Session at
the end.**

- ▶ Please post questions in the “chat” box.

AURI Programming

Nonprofit corporation created by MN legislature to increase utilization of MN's rich agricultural resources

Mission: Foster long-term economic benefit for MN through value-added ag products



Food



Coproducts



Biobased Products



Renewable Energy

Commercialization Services

- Private / One-to-One Projects
- Business, feasibility, hands-on technical assistance
- Entrepreneur in Residence: Lab/Equipment Sharing

Public Initiatives

- Free to the world
- Applied R&D for the industry
- Ag Innovation Partnership: catalyze activity



- Industry Convenings
- Public dissemination: Research projects / reports
- Webinar Wednesday, Fields of Innovation

AURI Guiding Principle

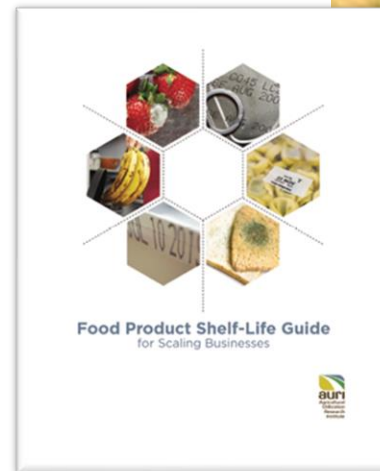
Transform MN's rich agricultural products into **sustainable** businesses

BY

Providing affordable access to consumer and science/technical expertise and infrastructure

If I could hug you I would- thank you for all your help today! I feel like I understand the path ahead of me much better and am excited to experiment using your suggestions. Thank you thank you thank you!

- Aspiring Entrepreneur



Food: Services and Facilities

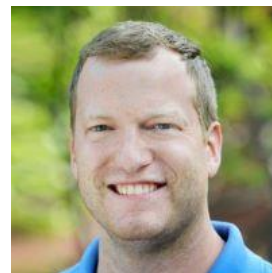
- Staff Expertise
 - Food Science, Processing & Packaging
 - Food business development
- Capabilities
 - Hands-on product development guidance
 - Nutrition facts labeling and analysis
 - Analytical food product testing
 - Regulatory guidance/assistance
 - Ingredient/packaging sourcing
 - Thermal process and food safety review
 - Product stability/shelf-life and scale-up
 - Co-packer or commercial kitchen networking
 - School meal crediting
- **Marshall, MN**
 - **Food / Meat Product Lab**
 - **Food Product Evaluation and Sensory Lab**
 - **Wet Chemistry Analytical Lab**



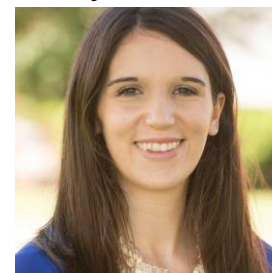
Jason Robinson



Lolly Occhino



Ben Swanson

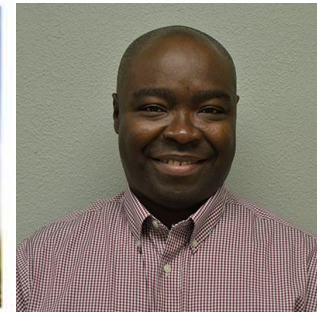


Ashley Harguth



Meet the Panel

- **James Anderson, PhD,**
UMN Professor Wheat
Breeding and Genetics
- **George Annor, PhD,**
UMN Assistant Professor,
Department of Food
Science and Nutrition
- **Brian LaPlante, CEO**
Back When Foods, Inc.
- **Harold Stanislawski, MS,**
AURI Business
Development Director
(Moderator)



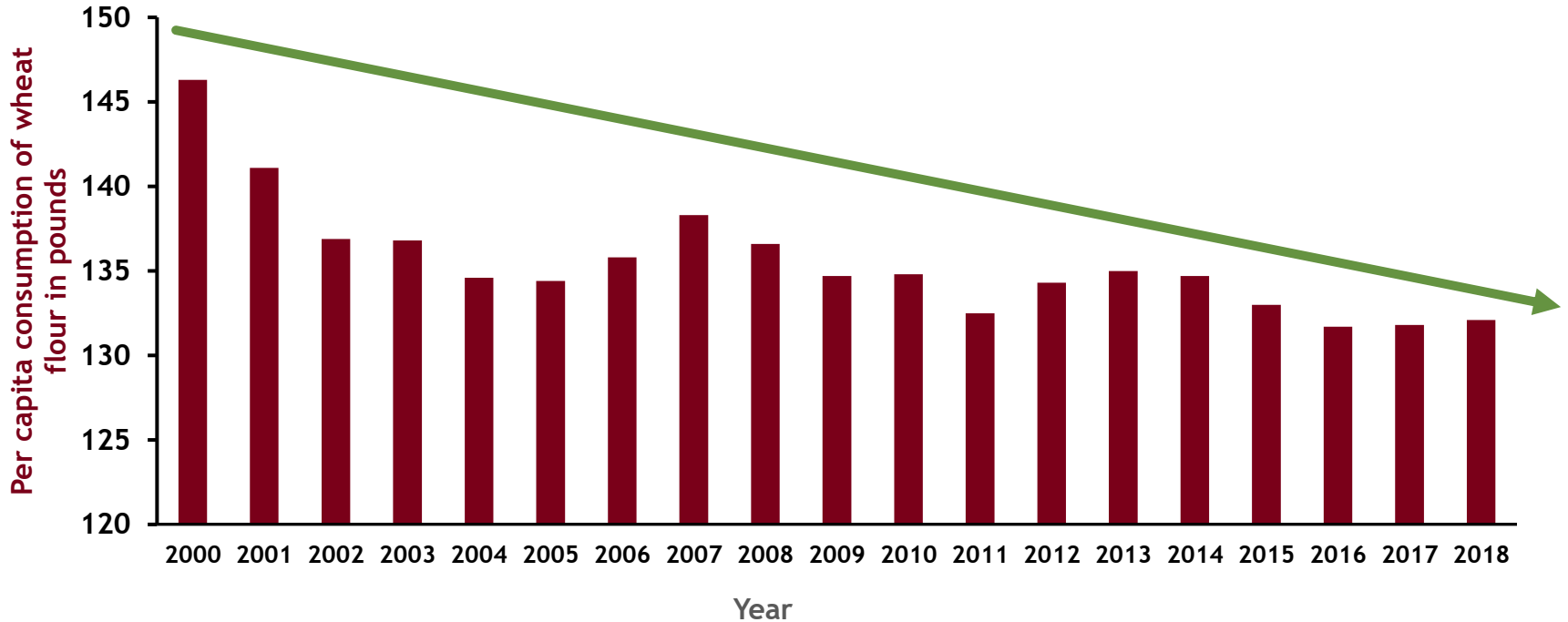
NOTE: Full bios available in the Chat box.

Tackling Wheat Digestibility: FODMAP and ATI Levels in Wheat Lines

- ▶ George Annor, James Anderson, and Prabin Bajgain



Per Capita Wheat Consumption in the U.S.



Source: US Department of Agriculture; Economic Research Service: Conducted by the Economic Research Service; US Department of Agriculture Survey period: 2000 to 2018



Why the Decline?

Fad diets



- ▶ Promotion of Fad diets, resulting in an increasing percentage of the population to remove starches from their diet
- ▶ Avoidance of Gluten and/or Wheat

<https://www.uab.edu/news/youcanuse/item/9287-fad-diets-or-lifestyle-changes-where-do-three-popular-weight-reduction-plans-fit-in>

Why the Decline?

Avoidance of Gluten and/or Wheat

- Gluten is a protein found in the grain of wheat, rye, and barley

- **Celiac disease**

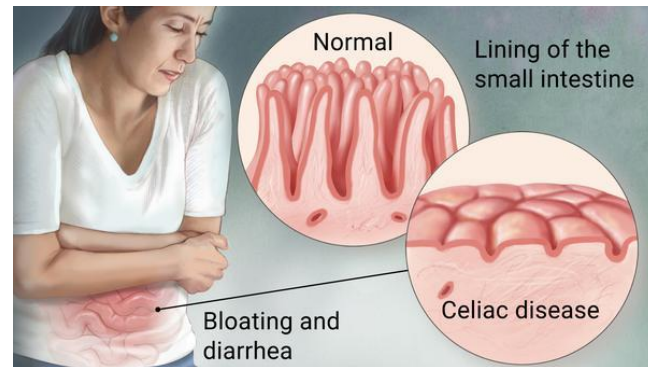
- Celiac disease is an immune disease in which people can't eat gluten because it will damage their small intestine
- ~1% of Americans have celiac.

- **Wheat Allergy**

- **Non-allergy-non-celiac wheat sensitivity (NCWS)**



<https://www.drperlmutter.com/yes-gluten-sensitivity-is-very-real/>



https://support.google.com/websearch/answer/2364942?p=medical_conditions&hl=en



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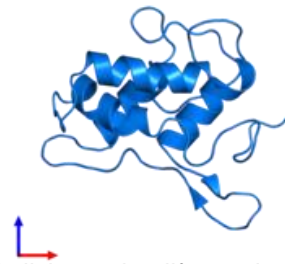
Why the Decline?

So, if it's not gluten per se, what are other possible causes of Non-allergy-non-celiac wheat sensitivity (NCWS)?

- ▶ FODMAPS -Fermentable Oligo-, Di- and Monosaccharides and Polyols
 - ▶ Fructose, lactose, fructo- and galactooligosaccharides (fructans, and galactans)
 - ▶ Polyols (such as sorbitol, mannitol, xylitol and maltitol)
- ▶ ATI - Amylase Trypsin inhibitors

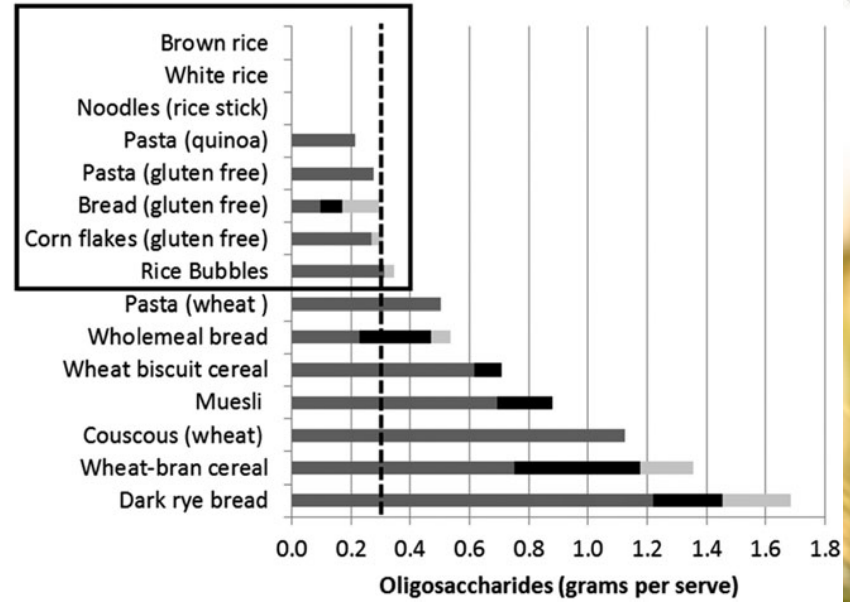
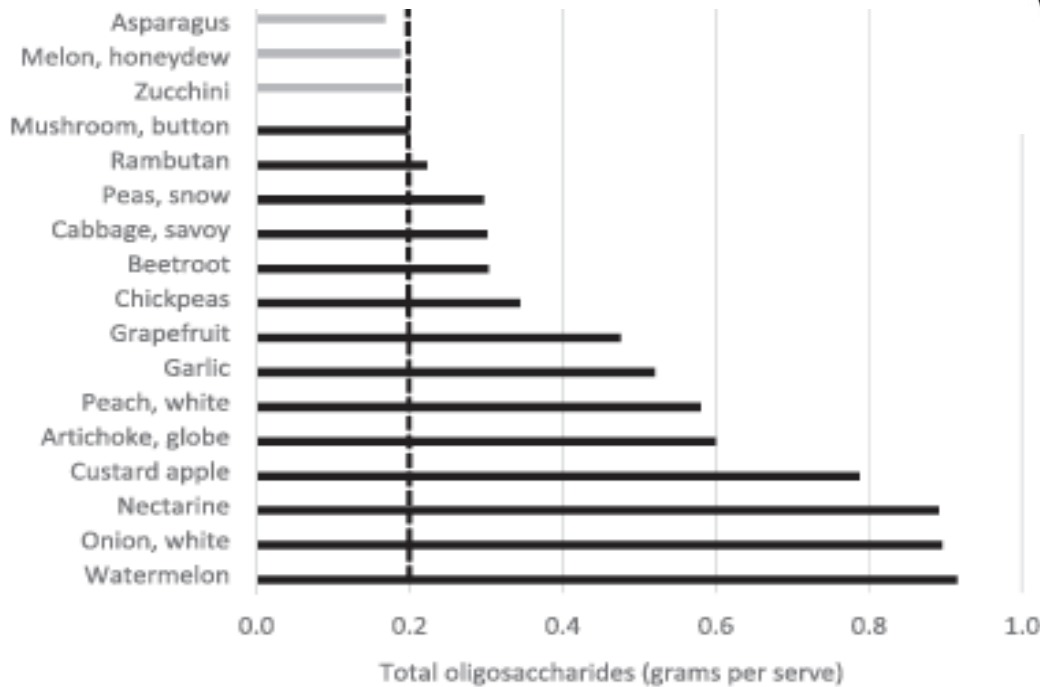


<https://enjoylifefoods.com/blogs/content/about-fodmap-friendly-living-enjoy-life-products>

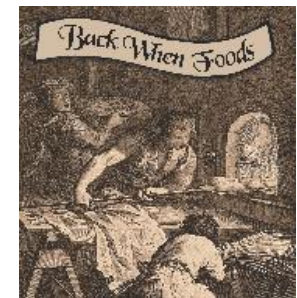


FODMAP Levels in some common foods

- Best tolerated if < 0.3 g/serve



Project Partners Agreed to Tackle Issue





- Reduce the discomforts resulting from the consumption of wheat-based products
- Improve the health of consumers
- Increase the profitability of wheat farmers

Specific Objectives

1. Characterize variation and identify genetic markers for FODMAPs and ATI activity in ancient, heritage and modern wheat varieties from different growing environments in Minnesota
2. Explore the use of fermentation as a technique to reduce FODMAPs and ATI activity in wheat food products
3. Establish a pathway for industry to implement research outcomes.



Materials and Methods

Objective 1

- ▶ A panel of 220 ancient, heritage and modern wheat varieties were grown at U of MN field sites at Crookston and St. Paul, MN in 2019
- ▶ Genetic markers were determined by extracting DNA from the panel of 200 wheat varieties and genotyped using Genotyping-By-Sequencing.
- ▶ Whole grains analyzed for % FODMAPs (via HPAEC) and ATI (HPLC)
- ▶ Association mapping was used to identify DNA markers associated with FODMAPs and ATI activity

Wheat Materials for FODMAP Evaluation

Material	No. lines
Heritage wheats:	46
Modern wheats (>1970):	142
Durum:	5
Einkorn (A genome):	10
Emmer: (AB)	11
Synthetic hexaploids (ABD):	16
Total:	230

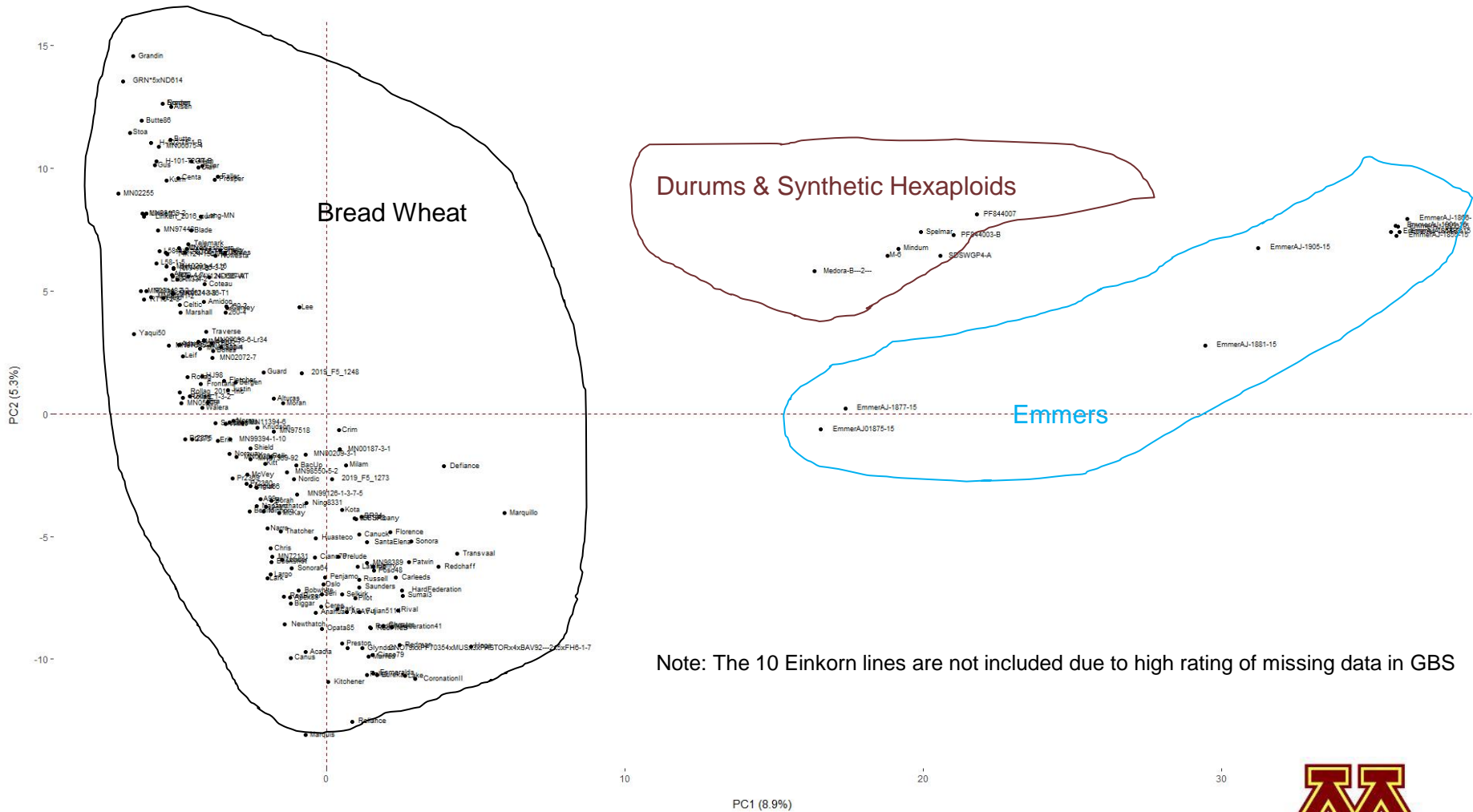
Lots of variation observed for heading date, height, yield



Preliminary Results



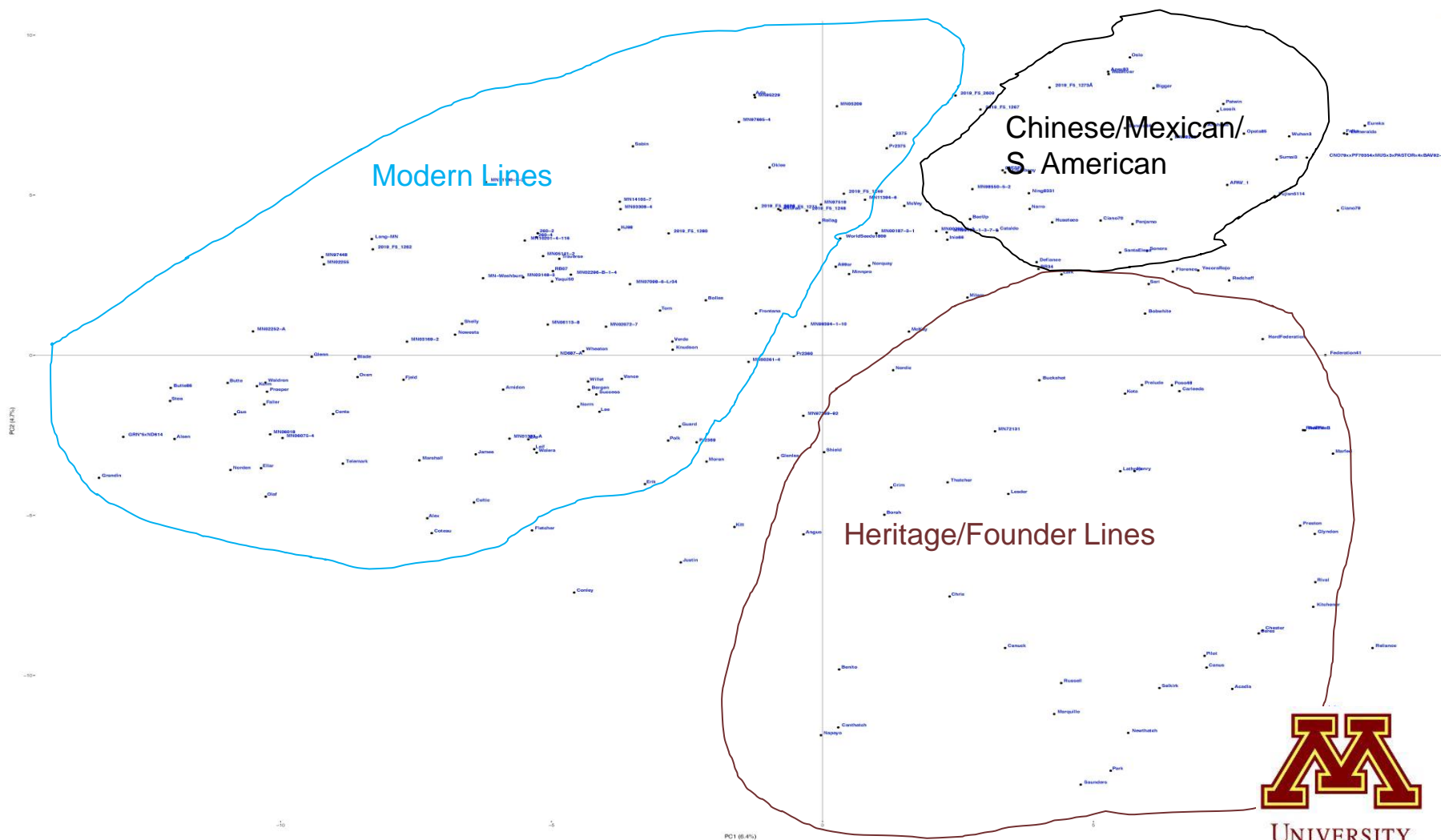
Genetic Diversity of 220 FODMAP panel lines



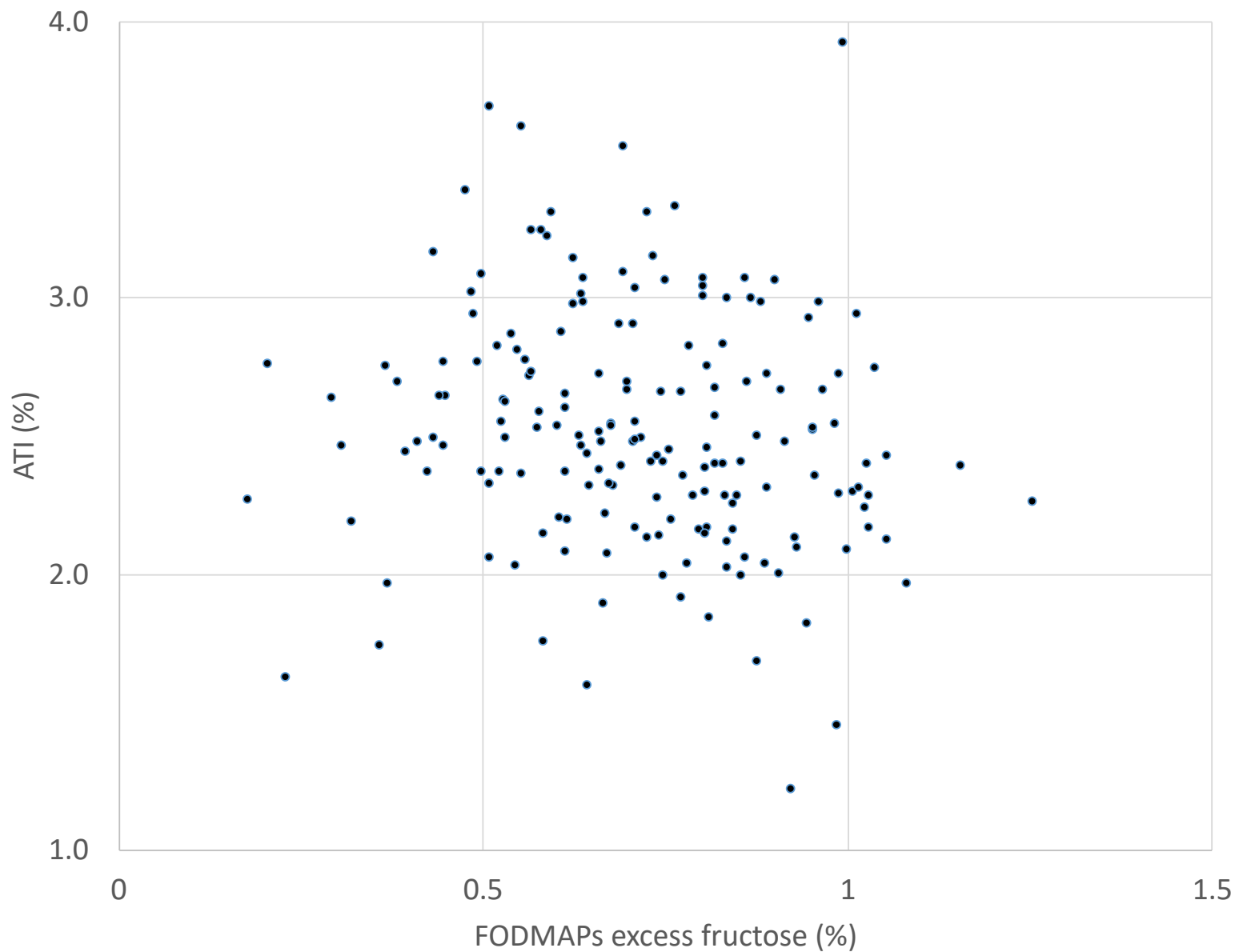
Note: The 10 Einkorn lines are not included due to high rating of missing data in GBS

Genetic Diversity of 190 FODMAP bread wheat panel lines

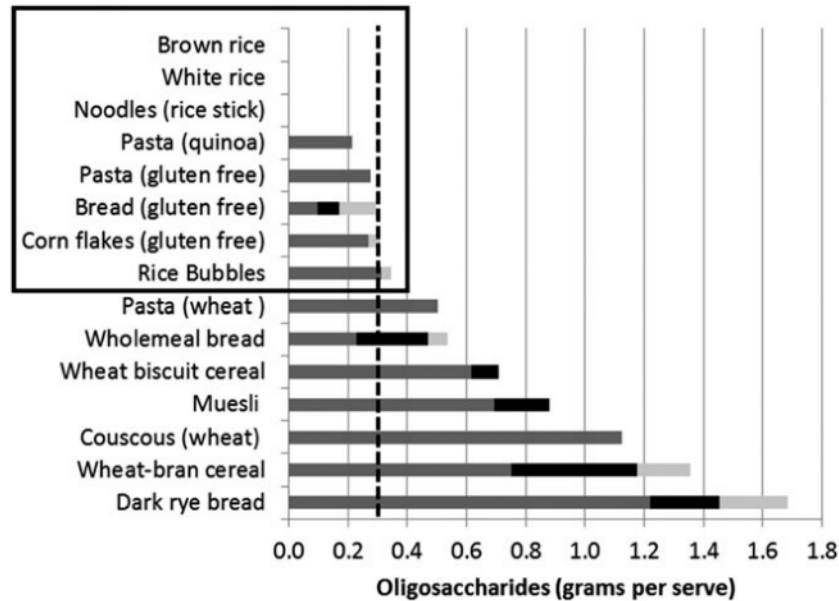
- Excludes durums, emmers, and synthetic hexaploids



ATI and FODMAP % of 167 Common Wheat Varieties



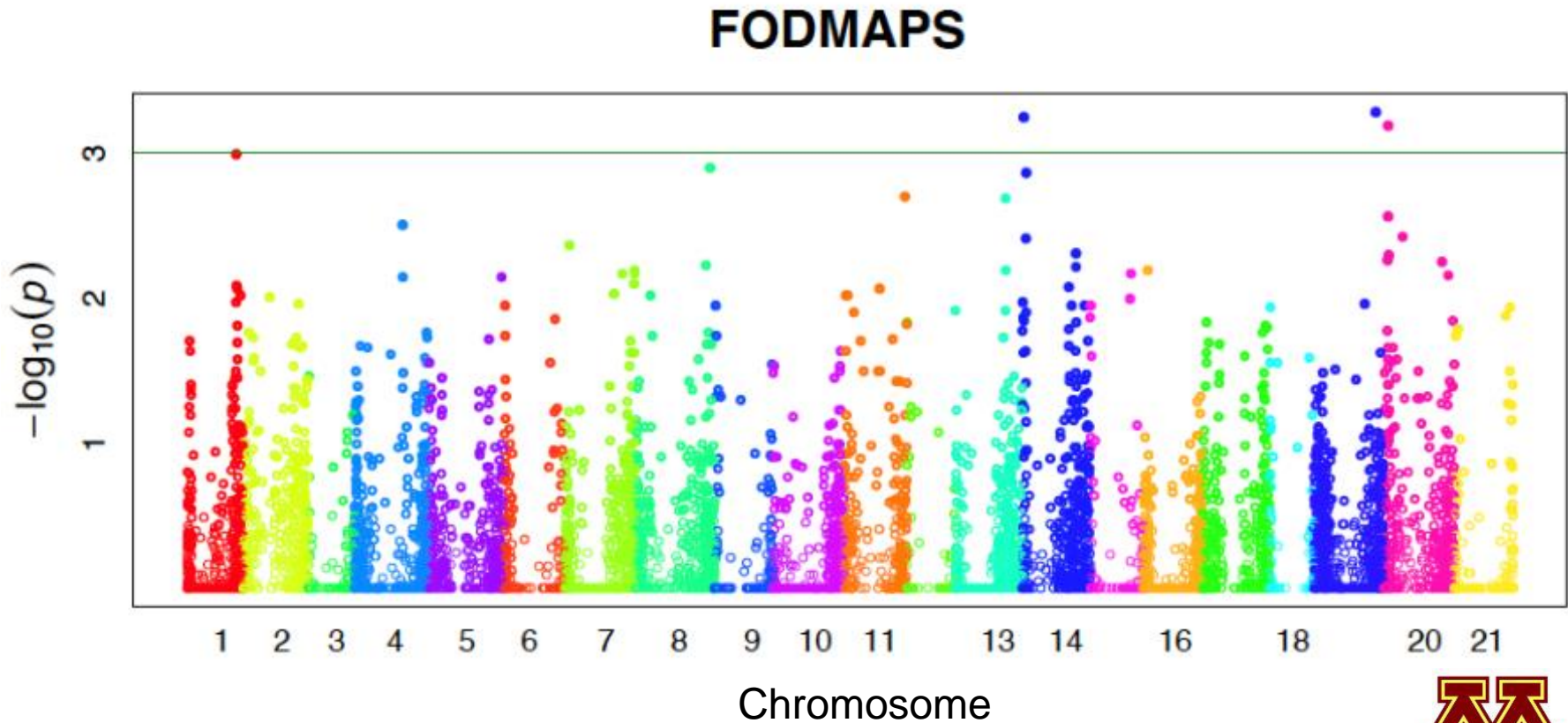
FODMAP Contents



Oligosaccharide content of gluten-containing and gluten-free grains. □, gluten free; ■, fructan; ■, galacto-oligosaccharides; ■, excess fructose.¹⁴

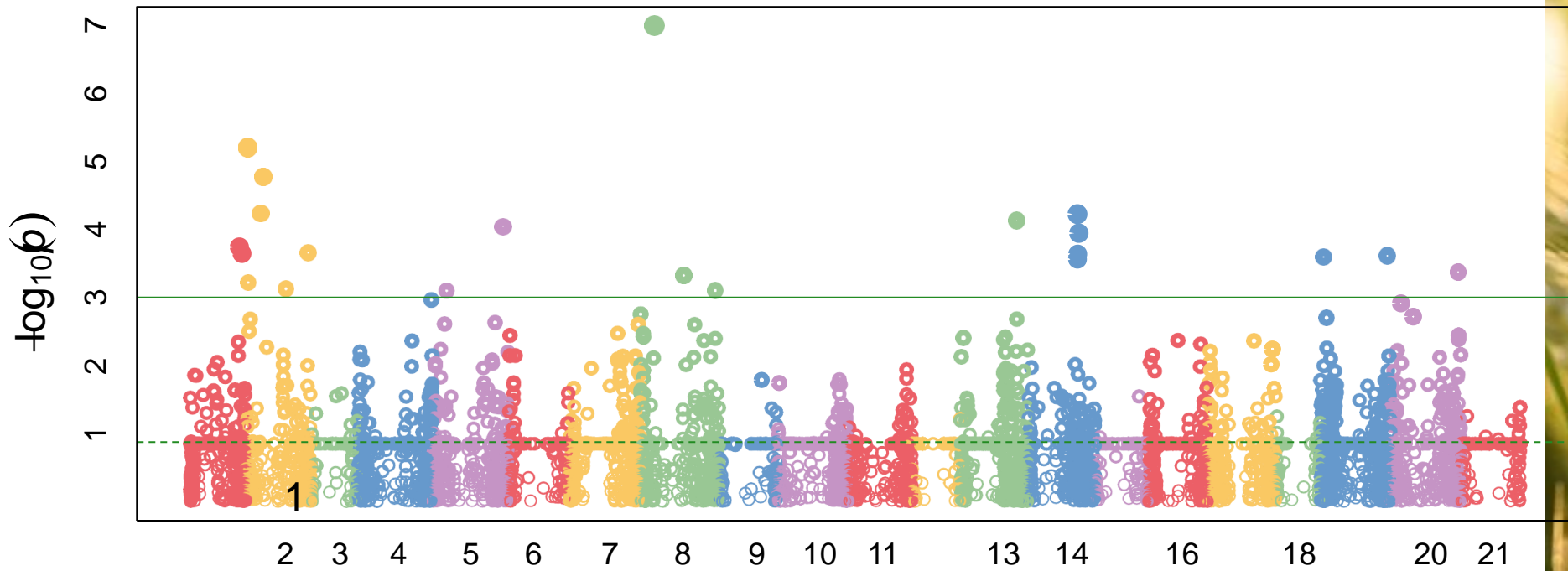
Varney, J., Barrett, J., Scarlata, K., Catsos, P., Gibson, P. R., & Muir, J. G. (2017)

Association of Genetic markers along the 21 wheat chromosomes with FODMAP content



Association of Genetic markers along the 21 wheat chromosomes with ATI content

ATI



Preliminary Findings Summary

- Genetically diverse set of wheat lines being analyzed
- Wide differences in FODMAPs and ATI Content
 - Among common wheat varieties:
 - FODMAPs 0.4-1.2%
 - ATIs 1.8-3.9%
 - Einkorn's low in ATI (1.3) and FODMAP (0.3); Emmer's low in FODMAP (0.4)
- No identifiable patterns regarding FODMAP and ATI concentrations vs. year of release among common wheat varieties
- No genomic region is responsible for a large portion of the genetic variation for these traits, but should be amenable to selection



Fermentation Study

Materials and Methods

Objective 2

Explore the use of fermentation as a technique to reduce FODMAPs and ATI activity in wheat food products

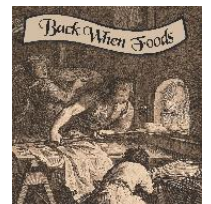
- ▶ Sourdough was prepared from wheat varieties to determine effects of different fermentation times on the levels of FODMAPs and ATI activity.
- ▶ Sample selection was based on the classification of the wheat varieties into low, medium and high FODMAPs and ATIs with 10 varieties from each group.



Sourdough Fermentation



Photo Credit: Rolf Hagberg

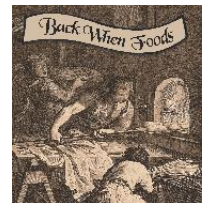


Sourdough Fermentation Overview

- ▶ Looked at the potential for sourdough to degrade or eliminate FODMAPs and/or ATI's.
- ▶ 10 varieties of each ranked by low, medium, and high FODMAPs and 10 varieties of each ranked low, medium, and high ATI from two locations—St. Paul and Crookston, MN.
- ▶ Type 1 sourdough fermentation model was applied to each of the wheat samples on a 4-hour and 12-hour fermentation cycle.
- ▶ A portion of the Type 1 sourdough was sequestered as a control.



▶ Photo credit: Suzanne Irwin

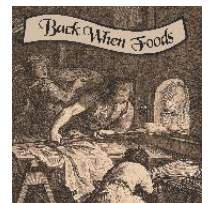


Sourdough Fermentation Overview - Type 1 Process

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Photo credit: Suzanne Irwin

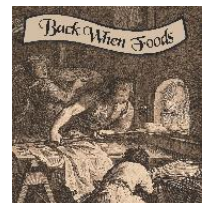


Sourdough Fermentation Outcome

- ▶ 600 individual test samples were completed and subsequently frozen and sent to Dr. Annor for analysis of the effect of fermentation on reduction to FODMAP and ATI's. This included 6 alternates from each location.



Photo Credit: Suzanne Irwin



Acknowledgements:

Emily Conley (Researcher)
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Nate Stuart (Researcher)
Prince Boakye (PhD Student)
Ibilola Kougbglenou (Researcher)

Funding:



Moderated Discussion Q & A Session

The Future is Bright

- ▶ Research results will benefit the value chain – wheat industry and consumers.
 - ▶ FODMAP Certification for food
 - ▶ Commercial Opportunities

Example: Commercial Opportunity

- Manildra Group – operates Australia’s largest flour mill
 - ▶ Launched low FODMAP flour in 2018
 - ▶ LoFo Pantry – has a U.S. operation (Manildra Group USA) marketing low FODMAP flour





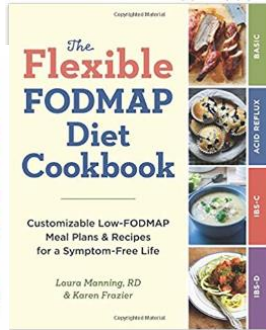
Low FODMAP Diet



world's first certified low FODMAP wheat flour and bakery range, developed by Australian family-owned international agribusiness Manildra Group.



Casabi Casabe Artisan Flatbread (Cassava Bread)



US Low FODMAP Food Distribution, the USA's first dedicated low FODMAP food distributor.



Low FODMAP Products ~ A Visual Guide ~ United States

Based on the low-FODMAP ingredients, these products appear to be safe for the low-FODMAP diet. Most are available in supermarkets, natural foods stores or online. Currently, they're not certified low-FODMAP. For a list of certified low-FODMAP products please visit <http://fodmaplife.com/low-fodmap-brands/>

The Future is Bright (cont.)

- ▶ **Phase II research proposed.**
 - ▶ Continuation of Phase I Research
 - ▶ Select wheat varieties from Phase I with low FODMAPs and ATI and breed for high amylose and resistant starch;
 - ▶ Investigate the expected glycemic index and characteristics of pasta and bread made from low ATI and FODMAPs wheat with high amylose and resistant starch;
 - ▶ Determine how the consumption of pasta and bread made from low ATI and FODMAPs wheat with high amylose and resistant starch affect the gut microbiome;
 - ▶ Establish a pathway for industry to implement research outcomes
- ▶ USDA Process Verified Program
- ▶ Low FODMAP Certification in Australia



MONASH
UNIVERSITY
LOW FODMAP
CERTIFIED™

Although many Schar products have been tested and certified low FODMAP by [Monash University](#), not every Schar product is low FODMAP. Here is a list including *some* of Schar's certified options available in the United States.

- [Deli-Style Seeded Bread](#)
- [Deli-Style Sourdough Bread](#)
- [Hamburger Buns](#)
- [Ciabatta Rolls](#)
- [Multigrain Ciabatta Rolls](#)
- [Hot Dog Rolls](#)
- [Baguette](#)

Call to Action

- ▶ In your opinion...
 - ▶ What would be needed to successfully market a product taking advantage of this research?
 - ▶ Please respond -- in the **Chat box or mention live.**

Resources & Upcoming Events

- ▶ **To learn more and follow this research, visit:**
www.auri.org/agri.

- ▶ **JOIN AURI & UMN for release of final research findings:**

AURI Fields of Innovation Webinar

- June 25, 2021 - 12 pm
- Stay tuned for registration details.

Thank You
for joining us!

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