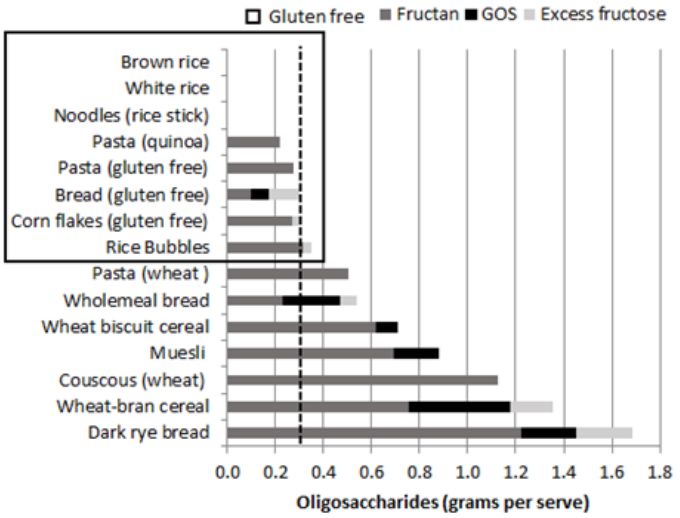
WHEAT DIGESTIBILITY

The Minnesota Wheat Research and Promotion Council (MWRPC), in partnership with the Agricultural Utilization Research Institute, the University of Minnesota, and Back When Foods conducted a study investigating options to reduce wheat digestibility concerns by identifying naturally occurring anti-nutrient elements in specific varieties of wheat.

Fermentable sugars known by the acronym “FODMAP” (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols) and “ATI” (amylase-trypsin inhibitor) proteins were the focus of this research.

FODMAPs are present in some common foods, but best tolerated if consumption is less than 0.3 grams per serving (approximately 2 slices of bread). *Levels found in common foods shown in the graph[1].*



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

Researchers believe these reactive components may be triggers of non-celiac gluten sensitivity and irritable bowel syndrome (IBS). Through insights gained in recent research into microbiology, it is also becoming apparent the human microbiome (the vast army of bacteria, fungi, and other microbes in the digestive tract) plays a critical role in maintaining or disrupting our health. Research conducted in 2019 found that ATI may kill or suppress good bacteria and enhance the bad bacteria in some people,leading to imbalances in the gut[2]. Current research illustrates that many individuals who suffer from digestive distress when consuming cereal grains may have an underlying dysbiosis (microbial imbalance or impaired microbiota). For such individuals, FODMAPs may become reactive, causing diarrhea, abdominal pain, distention, and bloating.

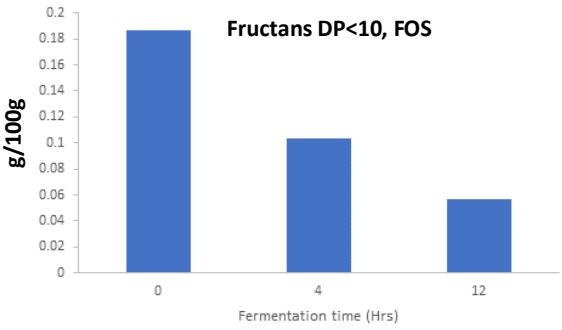
The current project funded by the Minnesota Department of Agriculture’s (MDA) Agricultural Growth, Research, and Innovation (AGRI) program investigated the level of ATI and FODMAPs present in current and past Minnesota wheat varieties, as well as their anti-nutrient levels, and the effects of fermentation on FODMAPs and ATIs after processing the wheat into a sourdough. The panel of 230 ancient, heritage, and modern spring wheat contained varieties introduced into the region in the 1800’s and derived from breeding and selection dating back to 1895.

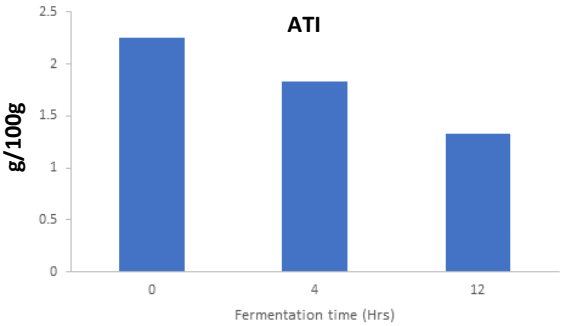
The proposed process of developing low reactive wheat food products is a combination of selecting the right wheat variety and alternative processing, such as sourdough fermentation, so that the ATI and FODMAPs are substantially reduced.

Research Findings

- Large variations were observed in FODMAP and ATI levels in the 220 (germinated) out of 230 wheat varieties screened, with FODMAPs and ATI levels ranging from 0.4 to 1.2 grams per 100 grams and 1.8 to 3.9 grams per 100 grams respectively.
- Einkorn wheat is low in FODMAP (0.3) and ATI (1.3); Emmer wheat is low in FODMAP (0.4). Both are ancient wheats. There appears to be no significant difference between heritage and modern varieties.
- No identifiable patterns were noted regarding FODMAP and ATI concentrations versus year of release among common wheat varieties.
- No genomic region is responsible for a large portion of the genetic variation for these traits but both traits should be amenable to selection using conventional breeding methods or genomic prediction.
- There are wheat varieties naturally low in FODMAP and ATI. Using a sourdough fermentation process is expected to result in wheat products with even lower levels of FODMAP and ATI for improved digestibility.
- Processing may play a bigger role than genetics in reducing FODMAPs and ATI.

WHEAT DIGESTIBILITY





Research Findings (cont'd)

Fermentation reduced the levels of fructans (a major component of FODMAPS) and ATI in the dough samples*:

- At 4 hours fermentation, fructans with a degree of polymerization(DP) < 10 (fructooligosaccharides) decreased by about 45% from 0.18 grams per 100 grams to 0.10 grams per 100 grams and by about 70% at 12 hours.
- At 4 hours of fermentation, fructans with a DP > 10 (inulins and raffinose) decreased by about 37% from 0.16 grams per 100 grams to 0.10 grams per 100 grams and by about 69% at 12 hours.

**Fructans fall into the oligosaccharides group. As observed, it is common for FODMAPs to increase during the fermentation period due to the increase in polyol production; however, the polyols evaporate during baking. Any decrease in the polyol content during baking will correlate to significant reduction in the levels of FODMAPs in the final baked product.*

- ATI levels reduced from 2.25 to 1.83g/100g at 4 hours fermentation time (an approximate 18% reduction)
- ATI levels reduced from 1.83 g/100g to 1.33 g/100g at 12 hours fermentation (an approximate 41% reduction)

Potential Benefits for Industry Impact

- New opportunities for wheat-based products, consumable by those with wheat digestion concerns.
- New market opportunities resulting from an increase in consumer demand for wheat-based products that could have a positive financial impact for the wheat industry, growers, and Minnesota.
- Benefits for supply chain participants as demand and volumes increase.

To learn more about his research and follow its progress, visit: www.auri.org/agri.

Next Steps

Using the wheat varieties identified in Phase I, Phase II research is also being proposed to build upon the current research results to further develop wheat varieties that not only have improved digestibility but also have higher amylose and resistant starch (fiber) for a lower glycemic index and improved gut health (microbiome).

Financial support for this project is provided by an Agricultural Growth, Research, & Innovation (AGRI) Crop Research Grant from the Minnesota Department of Agriculture. The AGRI program awards grants, scholarships, and cost shares to advance Minnesota's agricultural and renewable energy industries. For more information about the AGRI program, visit www.mda.state.mn.us/ grants/agri. To learn more about AGRI Crop Research Grants, visit www.mda.state.

[1] Reproduced with the permission of Monash University, Journal of Gastroenterology and Hepatology, Volume: 32, Issue: S1, Pag es 53-61, First published: 28 February 2017, DOI: (10.1111/jgh.13698).

[2] "Dietary Wheat Amylase Trypsin Inhibitors Modify the Gut Microbiome by Antimicrobial Activity and Aggravates Experimental Colitis" Pickert, Wirtz, Heck, Thies, et.al. (2019).