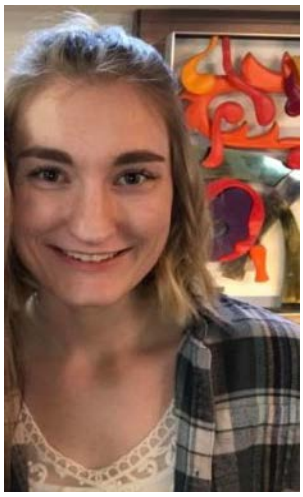
Plant Pathology Seminar Series

"The engineering of low-gluten wheat using the gene-editing technique CRISPR/CAS9"



By: Lauren Braley

Wheat is one of the most widely grown crops in the world[6]. It has become a fundamental component of the human diet over time, providing a large source of essential nutrients including the protein complex gluten[3,4,6]. Gluten proteins provide wheat with its unique viscoelastic properties that makes it essential in bread and pasta products[5,6]. However, to 1% of the world's population (approximately 78 million individuals) these proteins also induce an inflammatory response in the small intestines that is associated with the common autoimmune disorder Celiac's disease (CD)[1,2,4,5,6]. Untreated CD can result in the atrophy of an individual's intestinal villi which leads to a lack of nutrient absorption, causing malnutrition, diarrhea, growth stunting, anemia, and fatigue as well as higher risk for other diseases[4]. The only known treatment at this time for CD is adherence to a strict and life long gluten-free diet, but this is difficult and expensive to maintain for most patients[4,5].

To provide accessible gluten-free diet options, researchers have made great effort to reduce the content of gluten proteins in bread and pasta wheat lines. Gluten is comprised of two different proteins, gliadin and glutenin, in which α-gliadin is considered the primary protein in inducing the immune response[4]. However, due to the high copy number of the α-gliadin genes present at the gliadin loci, plant breeding and mutagenesis have been unsuccessful in eliminating or altering these genes[6].

In this seminar, I will introduce the latest research on the use of CRISPR/CAS9 as a precise gene-editing tool to engineer low-gluten wheat plants. The researchers showed a success in reducing overall gliadin content within target regions[6]. The effects in the engineered wheat lines resulted in no difference in overall seed protein content, while immune reactivity of the produced flour was decreased significantly, and the resulting gene knockouts were found to be stable and heritable[6]. In the field of gluten-free wheat biotechnology, this is considered a large advance forward. Although it is still not fully understood how the gliadin reduction will affect flour baking quality as well as abiotic stress and disease resistance, the data provides an important starting point for wheat and plant breeders moving forward in this field[6]

4:10 pm | Monday, April 6th, 2020 | *ZOOM ONLY—Meeting ID:148-370-013*

Plant Pathology 515 Fall Seminar Series

College of
Agricultural, Human, & Natural Resource Sciences
Washington State University

References

1. Ciccocioppo, R., Kruziak, P., Cangemi, G.C., Pohanka, M., Betti, E., Eugenia, L., and Rodrigo, L. (2015). The Spectrum of Difference between Childhood and Adulthood Celiac Disease. *Nutrients* 7: 8733-8751. doi: 10.3390/nu7105426.
2. Lu, Z., Zhang, H., Luoto, S., and Ren, X. (2018). Gluten-free living in China: The characteristics, food choices and difficulties in following a gluten-free diet – An online survey. *Appetite 127*: 242-248. doi: 10.1016/j.appet.2018.05.007.
3. Osorio, C.E., Wen, N., Meijias, J.H., Liu, B. Reinbothe, S., von Wettstein, D., and Rustgi, S. (2020). Development of wheat genotypes expressing a glutamine-specific endoprotease from barley and prlyl endopeptidase from *Flavobacterium meningosepticum* or *Pyrococcus furiosus* as a potential remedy to celiac disease. *Functional and Integrative Genomics 19 (1):* 123-136. doi: 10.1007/s10142-018-0632-x.
4. Ribeiro, M., Nunes, F.M., Rodriguez-Quijano, M., Carrillo, J.M., Branlard, G., and Igrejas, G. (2018). Next-generation therapies for celiac disease: The gluten targeted approaches. *Trends in Food Science and Technology 75*: 56-71. doi: 10.1016/j.tifs.2018.02.021.
5. Ribeiro, M., Picascia, S., Rhazi, L., Gianfrani, C., Carrillo, J.M., Rodriguez-Quijano, M., Branlard, G., and Nunes, F.M. (2019). Effect on in situ gluten-chitosan interlocked self-assembled supramolecular architechture on rheological properties and functionality of reduced celiac-toxicity wheat flour. *Food Hydrocolloids 90*: 266-275. doi: 10.1016/j.foodhyd.2018.12.026.
6. Sánchez-Leon., S., Gil-Humanes, J. Ozuna, C.V., Giménez, M.J., Sousa, C., Voytas, D.F., and Barro., F. (2018). Low-gluten, nontransgenic wheat engineered with CRISPR/CAS9. *Plant Biotechnology Journal 16*: 902-910. doi: 10.1111/pbi.12837.