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As an autoimmune disorder, celiac disease is difficult to diagnose and to date, the preferred treatment is abstinence. How will your research benefit these individuals?

Celiac disease is a genetic digestive disease and autoimmune disorder that damages the small intestine and interferes with absorption of nutrients from food. Symptoms are broad, ranging from cramps and diarrhea to malnutrition. The disease is triggered by consumption of gluten, a protein found in cereals such as wheat, barley and rye. Adopting a gluten-free diet, eliminating all wheat, rye and barley-based foods is today's most efficient treatment. Gluten is also used as a filler or binder in many additional food and non-food items, such as deli-meats, licorice, medicines, vitamins and even the adhesive on stamps and envelopes.

The laboratory of Diter von Wettstein, Washington State University (WSU) Pullman, and my group at the Justus-Liebig-University (JLU) in Gießen, Germany, have collaborated since 2008, when von Wettstein received a one-year DFG-funded Mercator professorship at the JLU, to generate new cultivars of wheat lacking gliadins, the critical protein fraction in the wheat gluten responsible for the disease. Today, the gluten must be removed from wheat flour in a time-consuming chemical process. This process could be bypassed by growing gluten-free wheat plants. We believe creating those gluten-free new cultivars of wheat will be of tremendous benefit for sufferers of celiac disease. Additionally, this modern breeding strategy will be much more sustainable and energy saving as compared with the chemical processing strategy.

What are the key challenges in developing a gluten-free grain?

Though I cannot elaborate here in detail because of the complexity of protein composition in wheat flour, a classical breeding program will not allow us to reach our goals in a reasonable time frame. Hence, a biotechnology-driven approach is the best alternative for generating gluten-free cereals. Von Wettstein identified specific mutations in barley genes affecting the gliadin-type gluten proteins. Specifically, it is the gliadins that cannot be digested and eventually cross the intestinal wall, causing a damaging T-cell response to the intestinal lining in celiac patients. Fortunately, it has been shown that eliminating the gliadins does not compromise wheat's baking qualities, which is an essential finding and a milestone we have reached. The scientific challenge is to specifically inactivate or inhibit those wheat genes coding for the gliadin fraction. We are utilizing new tailored techniques in molecular biology, such as RNA interference and the mutagenesis-based tilling to help to remove those genes.

However, there is another type of challenge in the project. In Europe we cannot test our improved wheat cultivars under field test conditions because of frequent devastation of field trials with genetically modified plants. This is, of course, a significant impediment to our research and in the long run, a detriment to sufferers of celiac disease. Therefore, it is essential for us to collaborate at the international level.

Based on your research, what are the main achievements of plant biotechnology for human health?

We are plant researchers, plant pathologists as a matter of fact, and as such my favorite answer is always that we have greatest potential in plant biotechnology for enhancing plant health. Notably, there is a direct connection to human health when we reduce plant disease caused by fungi-producing mycotoxins that seriously contaminate our food and feed. Those mycotoxins are a real threat to plant production as they belong to the most poisonous compounds in nature.

Another example that demonstrates the benefits of plant biotechnology comes again from our own research. We and other laboratories have produced hypoallergenic vegetables, such as tomatoes and carrots that can be consumed by allergy patients without harm. Actually, in Europe 2% of the population suffers from food allergies. Interestingly, the major allergen in those vegetables – the so-called PR10 protein – is involved in plant defense and thus is required to help plants survive from attacks of microbial pathogens. Here, the scientific challenge is to produce low allergenic plants that retain their natural resistance under field conditions. We were happy to generate hypoallergenic plants lacking the PR10 protein that turned out to be non-allergenic to patients and still able to defend against pathogens.

With the world population projected to reach 7 billion by this October and a growing societal awareness for sustainability, what will be the future role of plant biotechnology?

There are only a few techniques in the history of science that have been adopted faster by the praxis than biotech crops – millions of farmers worldwide use this “green” technology. We see great advantages in the field for better energy resource management, but also, of course, in reducing pesticides and stabilizing crop yields. As a scientist I would reckon that the synergy between plant biotechnology attempts and organic production – presently a fad in Europe and, as such, probably with an overestimated potential would make food and feed safer. A significant part of the European population, for instance, is not aware of safety problems stemming from “organic” fertilizers.

What is the connection between plant root diseases and climate change?

We can only speculate on this topic. My major concern with this is that enhanced soil temperatures could dramatically support root diseases caused by necrotrophic microbial pathogens that are all mycotoxin producers. If this is so, we have to face the fact that climate change will immediately impact food safety issues.