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Using Biotechnology to Increase Seed Production and Sustainable Vegetable Oil Yields in Soybean

The inflation of population in the world has led to a high and consistent food demand which has reinvigorated worldwide interest to create high-yielding varieties of legumes. Soybean *Glycine max* (L.), native to eastern Asia, and a member of the legume family has become one of the most important and essential food crops due to its oil and protein contents and demand. Major consumers of soybean products are the food, nutritional, pharmaceutical, cosmetic, and bioenergy industries. Nowadays, soybean provides 22% of the worldwide vegetable oil, and its seeds contain 20% and 40% of the oil and protein, respectively. These percentages necessitate being increased since soybean have the potential to feed the world and improve agricultural economics. To improve this, high-throughput efficient cell culture systems capable of genetic transformation and regeneration are necessary for studying protein disulfide isomerase (PDI) gene functions and germplasm improvement. We will employ two orthologs PDI reported in Arabidopsis to improve seed size/production and subsequently increase oil yields. For that reason, we rationalize that *Glycine max* PDI genes are valuable target genes to improve seed properties and so to enhance edible oil traits in soybean. Thus, our study focuses on developing reliable transformation and regeneration methods for soybean to enable the cloning of PDI genes with CRISPR/Cas9 technology. This will lead us to a better understanding of the PDIs gene's role in seed development and oil production in soybean. Additionally, it will provide fast and reliable methods to alter the genes of this crop. Thus, using a multi-disciplinary approach including cell and tissue culture, genetics and genomics, biochemistry, biotechnology, and bioinformatics, three objectives to investigate are i) Transformation of established soybean cell culture systems with CRISPR/Cas9 genome-editing technology. ii) Regeneration of CRISPR/Cas9 cell lines to obtain soybean plantlets. iii) Genetic characterization of CRISPR lines. Currently, we produced cell lines of two varieties of soybean, Williams83 and Henderson that are being employed for transformation and regeneration. We found that cell lines of both varieties display good cell density and viability up to 1.69 mg/ml - 1.85 mg/ml for density and 82-90% for viability. Both established cell lines were first tested for transformation efficiency using Agrobacterium carrying a control plasmid vector pANIC10A. We found that up to 54-65% transformation efficiency was obtained for both varieties. The regeneration step of transgenic plants from soybean cell lines as well as the cloning of *Glycine max* PDI genes through CRISPR/Cas9 technology are in the process.