FARMER

Exposure to extreme weather conditions causes canola seeds to stay green at maturity.

GRADER

Mean Green Machine is a seed grading machine alongside a software called the GreatGrader that uses computer vision to grade seeds.

OIL PRODUCER

The oil pressed from green canola seeds contains chlorophyll, which lowers the quality of the oil.

MARKET

The green seed problem is the largest problem in the canola industry.

ACHIEVEMENTS

* Analyzed the market by meeting with over 30 stakeholders from every part of the canola industry
* Submitted 28 BioBricks to the iGEM registry as part of a novel chlorophyll capture and degradation collection
* Successfully produced, purified, and emulsified 66K protein using our generated phase diagrams, allowing us to remove chlorophyll from green oil with a higher oil recovery than acid activated slurry at the same processing conditions
* Successfully utilized iGAM to create Mod66K, an improved version of 66K with increased stability
* 66K-tag purified 7-HACR and PPH using ICARUS, a spacer designed to overcome problematic electrostatic interactions between the protein and His-tag (Zhang et al., 2017)
* Created BOTS, a codon and synthesis optimization tool for parts design
* Successfully converted phosphorbin into phosphorbin a using PPH
* Characterized phosphorbin a’s ability to inhibit the growth of canola pathogen S. sclerotiorum
* Generated weather predictions 6 months in advance with a Mean Absolute Error within 2.5 degrees Celsius by utilizing the Principal Neural Network Mean Model
* Achieved low error in grade in Canadian Grain Commission-conducted tests of Mean Green Machine with a grading time of less than 5 minutes
* Developed, piloted tested, and distributed a university level synthetic biology course to 5 other iGEM teams

REFERENCES


ATRIBUTIONS

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Phosphorbin a as an Antifungal
Sclerotinia sclerotiorum - one of the most prevalent fungal pathogens among canola crops, resulting in major losses to farmers (Kobuta et al., 2008)

Mod66K showed improved stability in emulsion.

CHLOROPHYLL EXTRACTION

Construct Design

Chlorophyll a

Structural and functional characterization of chlorophyll degradation enzymes with ICARUS spacer

Phosphorbin a

Phosphorbin a

ICARUS

IGEM Calgary’s Augmented Repulsion Universal Spacing

Designed to allow purification of large electronegative proteins

Chlorophyll b

Chlorophyll b

Methionine (S-propionyl)(S-3methyl)-3-(S-propionyl)

Phosphorbin a

Phosphorbin a

PHOTOTROPHIC prokaryotes

Figure S. Emulsion classification in phase diagrams generated from experimental data.

Figure 8. Percent chlorophyll removal at various emulsified protein concentrations for 66K and BSA control at room temperature.

There are diminishing returns in 66K efficiency at higher concentrations due to its instability at the oil-water interface.

Using iGAM, we created Mod66K, an improved 66K protein with 12 amino acid changes. Protein dynamics modeling of Mod66K showed improved stability in emulsion.

PHOTOTROPHIC prokaryotes

Figure 10. Phosphorbin a produced by P. clara activated by chloroplast chlorophyll a reductase.

Figure 9. Phosphorbin a produced by P. clara activated by chloroplast chlorophyll a reductase.

Figure 7. Enzymatic degradation of chlorophyll a into phosphorbin a with predicted structural modeling for enzymes in the pathway using flowfit comparative and ab initio methods. ICARUS is in red.

Figure 11. Mycelial growth of S. sclerotiorum with phosphorbin a in dark (left) and light (right) conditions.

Figure 5. Percent oil recovery when chlorophyll recovery is 100% for 66K and 66K emulsion treatments.