BRC Science Highlight
February 2021

Biotin Attachment Domain-Containing Proteins Mediate Hydroxy Fatty Acid-Dependent Inhibition of Acetyl CoA Carboxylase

Background/objective

Naturally occurring specialized fatty acids (FAs) have potential as desirable chemical feedstocks if they could be produced at large scale through crop improvements. However, transgenic expression of their biosynthetic genes has generally been accompanied by dramatic reductions in oil yield due to feedback inhibition. Acetyl-CoA carboxylase (ACCase) catalyzes the first committed step in FA synthesis and is often considered rate-limiting. In this study, scientists tested the hypothesis that two biotin attachment domain-containing (BADC) genes in Arabidopsis are responsible for the hydroxy fatty acid-dependent inhibition of fatty acid synthesis.

Approach

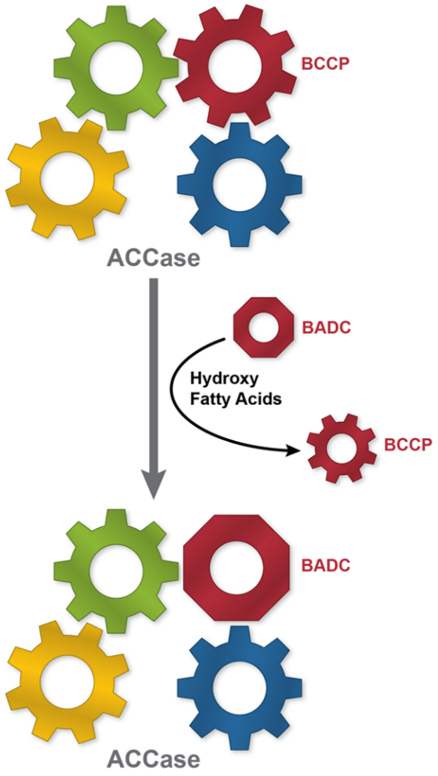
- Castor fatty acid hydroxylase-expressing plant background was crossed with a *badc1/3* double mutant.
- Genetic screening was used to identify homozygous quad gene combination making hydroxy fatty acids.
- Oil content, composition, and yield of these plants was measured and found to be the same as normal plants.

Results

- The rate of FA synthesis in badc1,3/fae1/FAH seeds doubled relative to *fae1*/FAH, restoring it to *fae1* levels, increasing both native FA and HFA accumulation.
- Total FA per seed, seed oil content, and seed yield per plant all increased in *badc1,3/fae1*/FAH, to 5.8 µg, 37%, and 162 mg, respectively, relative to 4.9 µg, 33%, and 126 mg, respectively, for *fae1*/FAH.
- Transcript levels of FA synthesis-related genes, including those encoding ACCase subunits, did not significantly differ between *badc1,3*/*fae1*/FAH and *fae1*/FAH.

Significance

The accumulation of high-value specialty fatty acids, such as hydroxys, is associated with dramatic reductions in seed oil yield. However, deletion of two BADC genes made plants “blind” to the hydroxy fatty acids, and oil yield was restored to normal levels, opening the door to producing renewable, value-added fatty acids at economic scale from carbon dioxide and sunlight. This strategy may be applicable to increasing the accumulation of other modified fatty acids in plants, and it might help improve the value of bioenergy crops and associated bioproducts.



A four-component plant enzyme, called ACCase, acts like a four-gear "machine" to crank out fatty acids. Small amounts of specialty hydroxy fatty acids cause BADC, which acts like a gear with no teeth, to replace BCCP, slowing production down.

Yu, X., et al., 2021. “Biotin Attachment Domain-Containing Proteins Mediate Hydroxy Fatty Acid-Dependent Inhibition of Acetyl CoA Carboxylase.” Plant Physiology. DOI: 10.1093/plphys/kiaa109

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