

Illuminating the mechanism behind how plants regulate starch synthesis

June 22 2021

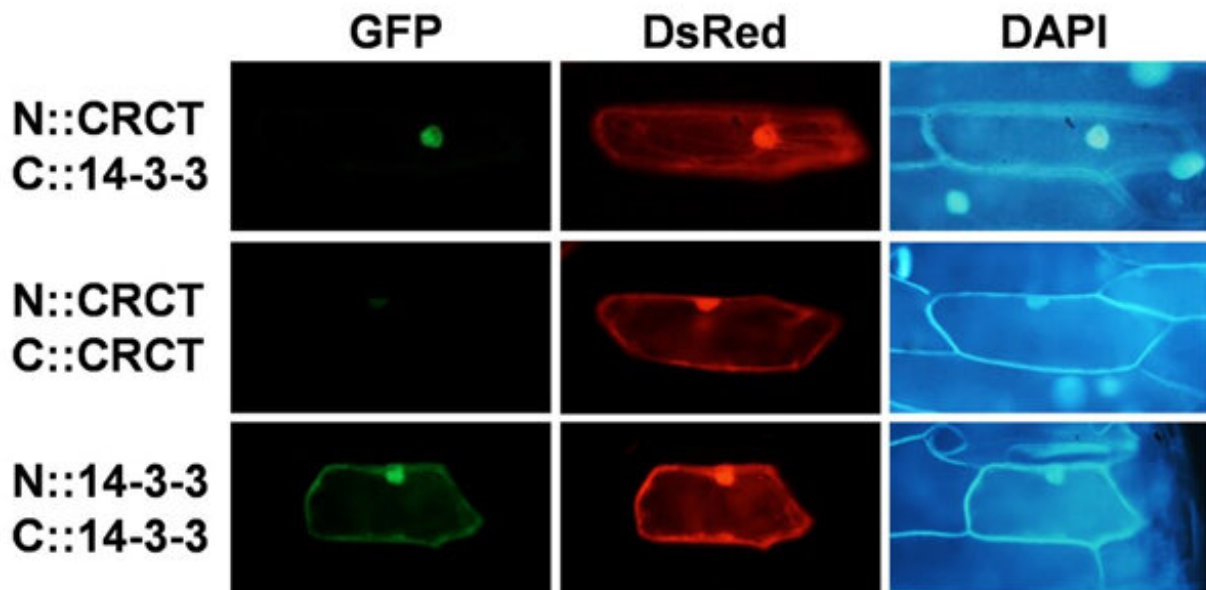


Figure 1: CRCT forming a complex with 14-3-3 protein in the nucleus. Credit: Kobe University

In a world-first, a Kobe University research group led by Associate Professor FUKAYAMA Hiroshi of the Graduate School of Agricultural Science has used rice to successfully illuminate the mechanism by which plants regulate the amount of starch produced via photosynthesis. This knowledge could contribute towards improving the quality and yield of agricultural crops.

These research results were published in the international scientific journal *Plant, Cell & Environment* on May 14, 2021.

Research Background

The increased concentration of CO₂ in the atmosphere is the main cause of global warming, which is a worldwide issue. However, it has been said that this could benefit plants as they convert CO₂ into starch via photosynthesis. If a crop is grown in conditions where there is an elevated concentration of CO₂, [starch synthesis](#) is accelerated, resulting in vigorous growth and increased yield. CO₂-Responsive CCT [protein](#) (CRCT) is activated in conditions where CO₂ concentration is high, however its function remained unknown. This research group has been investigating these proteins using rice plants, and previously discovered that CRCT is an important protein that regulates starch synthesis. In their latest findings, the group have revealed how CRCT regulates this process, which was not understood until now.

Research Methodology and Findings

Various proteins are required for starch synthesis in plants, including glucose 6-phosphate/phosphate translocator, ADP-glucose pyrophosphorylase, starch synthase and starch branching enzyme. The researchers hypothesized that CRCT regulates the expression of multiple genes corresponding to these starch synthesis-related proteins. Proteins that regulate [gene expression](#) are called transcription factors. In many cases, these transcription factors form a complex with another protein. When the researchers analyzed the volume of CRCT inside a plant, they discovered that it can form a complex with some types of protein. To investigate this further, they performed an analysis using an antibody that specifically binds to CRCT, which revealed that CRCT binds to 14-3-3 proteins. From another analysis, this time using green fluorescent

proteins, the research group illuminated that CRCT and 14-3-3 protein form a complex inside the nucleus (Figure 1). They also indicated the possibility that CRCT moves into and becomes activated in the starch-storing parenchyma cells after being synthesized in the phloem's vascular bundles. Furthermore, the researchers revealed that CRCT promotes transcription by binding to regions that regulate the expression of multiple starch synthesis-related genes.

It is known that there is a negative correlation between the expression of 14-3-3 proteins and the amount of starch. However, our results showed that there is a positive correlation between the amount of starch and the expression of CRCT. Consequently, the research group assumes that 14-3-3 protein and CRCT form an inactive complex (Figure 2).

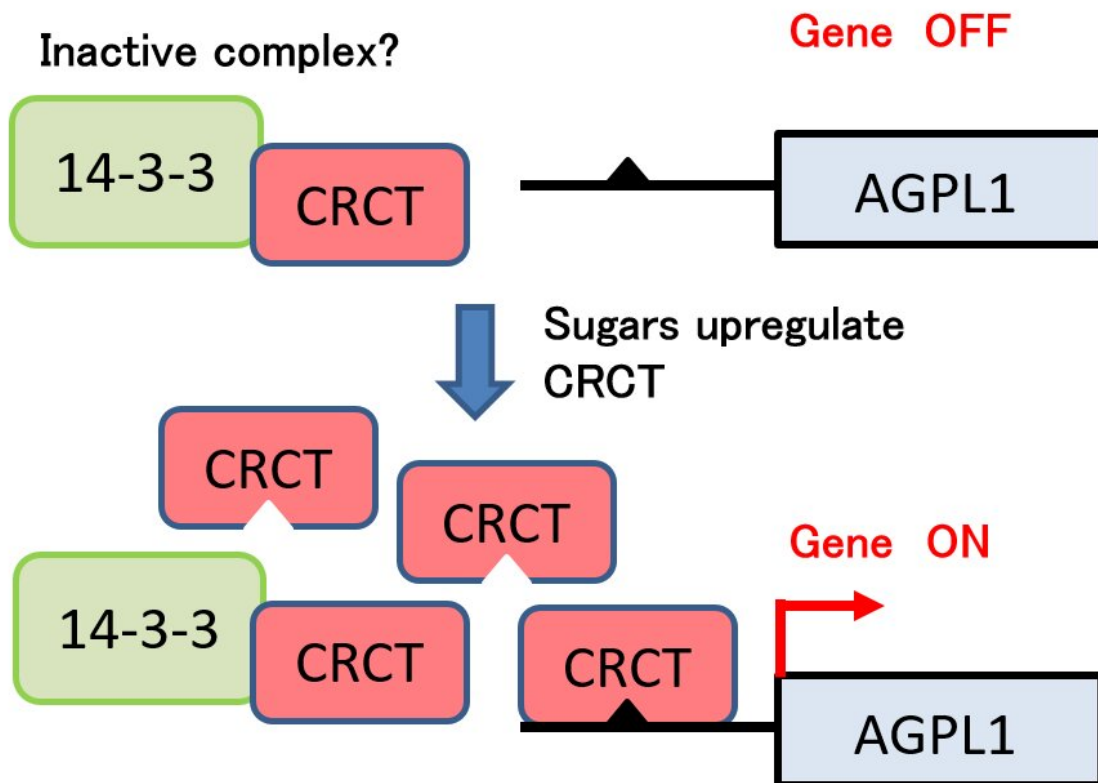


Figure 2: Hypothesized CRCT-mediated mechanism for starch synthesis regulation CRCT binds with 14-3-3 protein in the nucleus to form an inactive complex. CRCT is then upregulated by sugars that were produced via photosynthesis. It is thought that the CRCT proteins which don't bind with 14-3-3 proteins bind to the regulation sites on genes related to starch synthesis (such as *AGPL1*) instead, and promote transcription. Credit: Kobe University

Further Developments

Starch synthesis is indispensable for [plants](#), and CRCT, which regulates this process, is a prime target for efforts to improve crop quality and productivity. In addition, CRCT is a gene that is activated under conditions where there is an elevated concentration of CO₂, and this knowledge will be useful for selecting suitable rice cultivars for such environments in the future. Furthermore, similar genes to CRCT have been found in every plant investigated so far. The research group is also currently investigating CRCT function in potato, a staple starch crop.

From an academic standpoint, there are still questions that need to be answered. Looking at the current research results, it can be supposed that CRCT proteins move between cells but the underlying mechanism is not known. Furthermore, it is not understood how CRCT changes its own expression level in response to CO₂ concentrations and sugar levels. If the mechanism behind CRCT-mediated regulation of [starch](#) synthesis can be fully illuminated, it will be possible to make even greater improvements to agricultural crops.

More information: Hiroshi Fukayama et al, CO₂-responsive CCT protein interacts with 14-3-3 proteins and controls the expression of starch synthesis-related genes, *Plant, Cell & Environment* (2021). [DOI: 10.1111/pce.14084](https://doi.org/10.1111/pce.14084)

Provided by Kobe University

Citation: Illuminating the mechanism behind how plants regulate starch synthesis (2021, June 22)
retrieved 2 May 2024 from

<https://phys.org/news/2021-06-illuminating-mechanism-starch-synthesis.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.