Second plant pathway could improve nutrition, biofuel production

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Purdue University scientists have defined a hidden second option plants have for making an essential amino acid that could be the first step in boosting plants' nutritional value and improving biofuel production potential.

The amino acid phenylalanine is required to build proteins and is a precursor for more than 8,000 other compounds essential to plants, including lignin, which allows plants to stand upright but acts as a barrier in the production of cellulosic ethanol.

It had been believed that plants could use two pathways to create phenylalanine. Natalia Dudareva, a professor of horticulture, and Hiroshi Maeda, a postdoctoral researcher in Dudareva's laboratory, have confirmed that while plants predominantly use one pathway, they have another at their disposal. The existence of this second pathway might one day allow scientists to increase a plant's production of the essential amino acid. Their research was published in the early online version of the journal Plant Cell.

"That would allow us to increase the nutritional value of some food," Maeda said. "But also by increasing these compounds, the plants would be better able to protect themselves from changes in the environment."

Maeda added that reducing phenylalanine could lead to a reduction of lignin in plants, which would improve digestibility of cellulosic materials for ethanol production.

Phenylalanine is one of the few essential amino acids that humans and animals cannot synthesize, so it must come from plants. It is produced when sugars enter a plant's shikimate pathway, which creates a link between the processing of sugars and the generation of aromatic compounds. The next steps had not been known until now, and were thought to involve one of two proposed routes - the phenylpyruvate or arogenate pathways.

Dudareva and Maeda found a gene responsible for phenylalanine production, and suppression of the gene expression knocked out 80 percent of the phenylalanine content in petunias. The hypothesis was that the gene suppression would act like a clogged pipe, creating an abundance of compounds that would have later become phenylalanine in a normal plant.

But that's not what happened.

"These plants knew that the last step of phenylalanine production was down and slowed the first steps," Dudareva said.

Maeda said the plant created some sort of feedback mechanism that slowed down the entry point of the shikimate pathway.

Dudareva and Maeda wanted to see what would happen if they forced the shikimate pathway to function, so they gave the petunias shikimic acid. The plants were flooded with the upstream compounds as expected, but since they could not use the usual arogenate pathway to convert them to phenylalanine, they used another path that scientists had only theorized existed.

"What this tells us is this other pathway could be active under certain conditions," Dudareva said.

Understanding how the pathways work is a first step in finding ways to increase phenylalanine for boosting nutritional values of foods, or decreasing it, which may help in biofuel production.

Dudareva and Maeda will next try to determine how the plant creates feedback to the shikimate pathway. Disrupting that feedback could lead to an abundant production of phenylalanine in plants. The National Science Foundation funded the research.

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