A new role for vitamin B6 in plants

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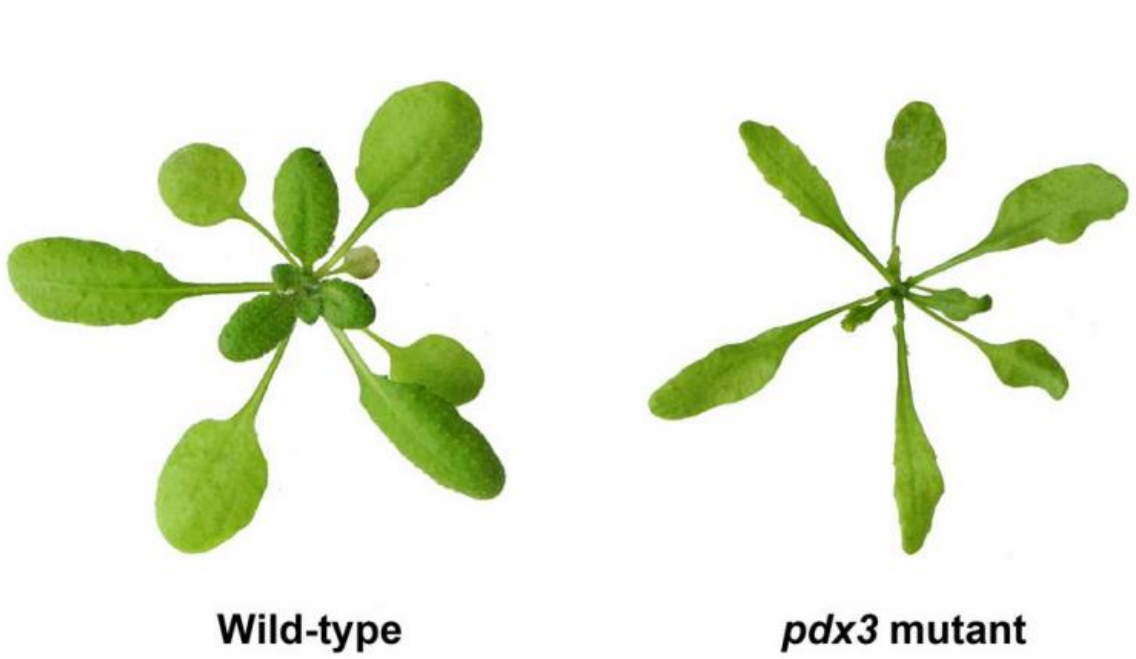

Young *Arabidopsis* plants are pictured. Credit: © Teresa Fitzpatrick, UNIGE

Vitamin B6, which exists in different natural forms called vitamers, is essential for all living organisms, as it participates in numerous aspects of cells' everyday life. Researchers from the University of Geneva (UNIGE), Switzerland, have discovered an unexpected role for this micronutrient, in relation to nitrogen metabolism. Described in the journal *The Plant Cell*, the results indicate that one of the vitamers informs the plant of its content in ammonium, a basic nitrogen compound needed for the biosynthesis of various molecules essential for

life, such as proteins. In the future, vitamin B6 could be used to ascertain the nitrogen status of plants and eventually prevent the overuse of nitrogen-containing fertilizers that are currently having detrimental effects on the environment.

Essential for all living organisms, Vitamin B6, which exists in six different forms called vitamers, is produced by plants, bacteria, and fungi, but not by animals. However, it is not known why organisms have several vitamers and if their balance (homeostasis) is of importance. In plants, the various vitamers can be produced via different specific pathways. "We study these pathways to determine their contribution to cellular vitamin B6 homeostasis and to growth and development", explains Teresa Fitzpatrick, professor at the Department of Botany and Plant Biology of the Faculty of Sciences of UNIGE, who led the study.

A surprising observation provides clues

In collaboration with the Max Planck Institute of Molecular Plant Physiology and the University of Düsseldorf (Germany), the researchers examined a version of the model plant *Arabidopsis thaliana* (thale cress), which is defective in the PDX3 enzyme. Surprisingly, these plants displayed strongly impaired growth and development. "PDX3-defective plants cannot transform a vitamer called PMP, therefore the latter accumulates within the cell. While we hypothesized that the observed anomalies may be due to the high levels of PMP, we had no idea of the underlying mechanism and questioned its precise contribution", says Maite Colinas, member of the Geneva team and first author of the study.

The answer came from an unexpected discovery: the observed growth anomalies of the mutants were completely abrogated when the plants were supplemented with ammonium. "In most natural soils the predominant nitrogen source for plants is nitrate, as they usually contain little ammonium. Plants must therefore import the former and convert it

to ammonium, which can then be used for the biosynthesis of nitrogenous compounds including proteins to promote plant growth", notes Teresa Fitzpatrick. It turns out from the scientists' investigation that the high levels of PMP in the PDX3-defective plants interfere with the conversion of nitrate into ammonium, resulting in an ammonium deficiency that is responsible for the impaired growth and development.

A new player in nitrogen metabolism

As the connection between nitrogen and vitamin B6 metabolism had never been made, the biologists further examined the potential interactions between these two processes in natural wild-type plants. They indeed observed a considerable accumulation of the PMP vitamer in plants supplemented with ammonium. "When the plant contains enough ammonium for its needs, further production from nitrate is prevented, thus limiting energy waste and potential toxicity that can happen if too much is made. The level of PMP probably informs the plant about its ammonium state", reports Maite Colinas.

While scientists knew that plants acquired nitrogen from nitrate or ammonium to meet their needs, they were uncertain of how the plant monitored the level or proportion of these compounds. Here, the researchers have found an unanticipated player in this process: the vitamer PMP. The group is currently investigating whether PMP regulates nitrogen metabolism directly or indirectly, via the action of other compounds. In the future, vitamin B6 could be used to ascertain the nitrogen status of plants and eventually prevent the overuse of nitrogen-containing fertilizers that are currently having detrimental effects on the environment.

Provided by University of Geneva