Identification of β-glucosidases responsible for glucosinolate catabolism under sulfur deficiency and the significance of this process in plant growth

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Title　：Identification of β-glucosidases responsible for glucosinolate catabolism under sulfur deficiency and the significance of this process in plant growth
(硫黄不足時のグルコシノレート分解に働くβ-グルコシダーゼの同定と植物の生長における意義)

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Thesis Summary

Sulfur (S) is one of the macronutrients necessary for plant growth and development. The primary source of S in the environment is inorganic sulfate. Sulfate can be absorbed into plants and assimilated into organic S compounds. This assimilatory process is defined as primary S metabolism, via which the primary S-containing metabolites, such as cysteine and glutathione, are produced. The plants belonging to the Brassicales order can produce a group of specialized S-containing metabolites named glucosinolates (GSL). Previous studies revealed that when plants face S deficiency (−S), they stimulate the primary S metabolism closely related to their survival. Instead, plants repress the GSL biosynthesis and would stimulate their catabolism. GSL catabolism is the famous “mustard oil bomb” in plant defense response against insect attack. However, the roles of this catabolic process under nutrient stress have not been elucidated yet.

GSL catabolism is catalyzed by ß-glucosidases (BGLUs). The increased expression level of *BGLU28* and *BGLU30* under −S indicated their roles in triggering GSL catabolism under this nutrient stress. To verify their function, we generated the double disruption lines of *BGLU28/30* (*bglu28/30*) using Arabidopsis as material. We observed that *bglu28/30* accumulated a higher level of GSL but reduced cysteine and glutathione levels under −S. Furthermore, *bglu28/30* displayed obvious growth retardation under −S. These results confirmed that BGLU28 and BGLU30 were responsible for GSL catabolism under −S. And very possibly, GSL can function as S storage compounds. Namely, upon their catabolism under −S, S in GSL is released and recycled to synthesize primary S-containing compounds essential for plant growth.

Motivated by these observations, as GSL profiles in plants vary among growth stages and organs, we further verified the potential contribution of BGLU28/30-dependent GSL catabolism at the reproductive-growth-stage plants. In this study, we further assessed the growth, metabolic, and transcriptional phenotypes of mature *bglu28/30* double mutants grown under different S conditions. Our results showed that compared to wild-type plants grown under −S, mature *bglu28/30* mutants impaired their growth and increased GSL levels in their reproductive organs and rosette leaves of the before-bolting plants. In contrast, the levels of primary S-containing metabolites, glutathione, and cysteine decreased in mature seeds. Furthermore, the transport of GSL from rosette leaves to the reproductive organs was stimulated in the *bglu28/30* mutants under −S. Transcriptome analysis revealed that genes related to other biological processes, such as ethylene response, defense response, and plant response to heat, responded differentially to −S in the *bglu28/30* mutants. Altogether, these findings broadened our understanding of the roles of BGLU28/30-dependent GSL catabolism in plant adaptation to nutrient stress.