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Export of defensive glucosinolates is key for their accumulation in seeds

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Background:

Plant membrane transporters that control metabolite distribution influence key agronomic traits in crops. Mutation of importers may eliminate anti-nutritional factors in edible parts, such as seeds. However, this often results in a substantially altered distribution pattern within the plant, which may have adverse effect on plant defence. In contrast, engineering of exporters may prevent such changes in distribution.

Objective:

In brassicaceous oilseed crops, anti-nutritional glucosinolate defence compounds are translocated to the seeds. However, the molecular targets for export engineering of glucosinolates remain unclear. In this study, we aimed to identify glucosinolate exporters (Xu et al. 2023).

Methods:

We selected candidate exporter genes based on co-expression with the glucosinolate biosynthetic machinery in the funiculus (Khan et al. 2015). Next, we screened knock-out Arabidopsis mutants for seed glucosinolate phenotypes and further biochemically characterized hits using the Xenopus laevis oocyte expression system.

Results:

We identified and characterized members of the USUALLY MULTIPLE AMINO ACIDS MOVE IN AND OUT TRANSPORTER (UMAMIT) family—UMAMIT29, UMAMIT30 and UMAMIT31—in Arabidopsis thaliana as glucosinolate exporters with a uniport mechanism. Loss-of-function umamit29 umamit30 umamit31 triple mutants have a very low level of seed glucosinolates, demonstrating that these transporters play a key role in translocating glucosinolates into seeds.

Conclusions:

We propose a model in which the UMAMIT uniporters facilitate glucosinolate efflux from biosynthetic cells along the electrochemical gradient into the apoplast, where the high-affinity H+-coupled glucosinolate importers GLUCOSINOLATE TRANSPORTERS (GTRs) load them into the phloem for translocation to the seeds. Our findings validate the theory that two differently energized transporter types are required for cellular nutrient homeostasis. The UMAMIT exporters are new molecular targets to improve nutritional value of seeds of brassicaceous oilseed crops without altering the distribution of the defence compounds in the whole plant.

References:

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