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DYRK-Type Protein Kinase, MpYAK1 is Involved in Regulation of Gemma Dormancy and Induction of Sexual Organs in the Liverwort *Marchantia polymorpha*

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Vegetative and sexual reproduction in plants is affected by environmental factors such as nutrient states and light conditions, and its regulation is critical for plants. We have reported that an algal protein kinase, a dual-specificity tyrosine-phosphorylation-regulated kinase (DYRK), TAR1, regulates cell viability and gametogenesis in carbon and nitrogen-imbalanced conditions in a green alga, *Chlamydomonas reinhardtii* [1]. TAR1 belongs to the Yak1 subgroup in the DYRK kinase family, which is evolutionarily conserved in plants, animals and fungi. However, the physiological functions of DYRKs in land plants are still largely unknown.

In order to understand the functions of land plant DYRKs, we characterized a *TAR1* ortholog (MpYAK1) in the liverwort *Marchantia polymorpha*. The MpYAK1 gene is present as a single-copy gene in the *M. polymorpha* genome. A MpYAK1-defective mutant, *Mpyak1^{se}*, was isolated using the CRISPR/Cas9 system. The *Mpyak1^{se}* had a frameshift mutation at the 5'-upstream region of kinase domain in the MpYAK1 gene. The phenotypic changes in the vegetative and sexual reproduction were observed between *Mpyak1^{se}* and wild-type (WT) or a complementation line expressing a WT MpYAK1 cDNA in the *Mpyak1^{se}* background. Gemmae in the gemma cup of *Mpyak1^{se}* prematurely germinated before release from the gemma cup. Under far-red light, days required for induction of sexual organs in both male and female *Mpyak1^{se}* lines were shortened, and the number of sexual organs in the *Mpyak1^{se}* lines increased significantly compared with WT and the complemented line in long-day photoperiods. The induction of sexual organs occurred in the both male and female *Mpyak1^{se}* lines even in the far-red light irradiated short-day photoperiods, in which conditions such sexual reproduction was not induced in WT and the complemented line. These results suggest that MpYAK1 is involved in the maintenance of gemma dormancy in the gemma cup and regulation of photoperiodically induction of sexual organs.

Reference:

1. Shinkawa, H., Kajikawa, M., Nomura, Y., Ogura, M., Sawaragi, Y., Yamano, T., Nakagami, H., Sugiyama, N., Ishihama, Y., Kanesaki, Y., Yoshikawa, H. and Fukuzawa, H. (2019) Algal Protein Kinase, triacylglycerol accumulation regulator1, modulates cell viability and gametogenesis in carbon/nitrogen imbalanced conditions. *Plant Cell Physiol.*, 60: 916–930.

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