
 ABSTRACTS (MASTER THESIS)

Metabolic engineering for isoprene production in algae

**(Graduate School of Agriculture,
Laboratory of Plant Gene Expression, RISH, Kyoto University)**

Takuya Asano

Isoprene is a volatile C5 hydrocarbon, 2-methyl-1,3-butadiene, which is used for the production of synthetic rubber and adhesives in a large amount [1]. The overall consumption over the world is ca. 1 million tons, while the source of isoprene is currently almost completely dependent on petrochemicals, for instance the isolation from C5 cracking fraction [2]. Because of the latent risk of resource depletion and also for lowering environmental load, isoprene production by living organisms have been attempted in recent years [3,4].

In nature, many microorganisms and plant species are known to emit isoprene to atmosphere. In particular, isoprene represents ca. 50% of plant-derived volatile organic compounds (PVOC) emitted to the air, which is calculated to be ca. 50 Tg carbon per year on the earth [5]. In order to establish the isoprene production by metabolic engineering, isoprene synthase gene was searched in plant species that are known as isoprene emitter plants. The first isoprene synthase gene was identified in poplar in 2001, and in Kyoto University another isoprene synthase gene *PaIspS* was isolated from *Populus alba* in 2005 [7].

We first tried to produce isoprene in transgenic plants, and used *Arabidopsis* as a model. However, the production level was too low, and more importantly the recovery of isoprene from the leaves seems to be practically unfesible. From these experiences we are trying to express *PaIspS* in a couple of microorganisms. The results are now summarized as a publication.

Acknowledgements

This study was conducted as collaboration with Dr. Kentaro Ifuku, Dr. Hideya Fukuzawa, and Dr. Masataka Kajikawa of Graduate School of Biostudies of Kyoto University, and Dr. Tomonori Okumura of Research Institute of Environment, Agriculture and Fisheries, Osaka Prefecture. This study was supported in part by a grant of Mission 5-2 of RISH, Kyoto University.

References

- [1] Bentley, F.K., Zurbriggen, A., Melis, A., 2014. Heterologous expression of the mevalonic acid pathway in cyanobacteria enhances endogenous carbon partitioning to isoprene. *Mol. Plant*, 7, 71-86.
- [2] Weissmehl, K., Arpe, H.J., 1992. *Industrial Organic Chemistry*. JohnWiley&Sons, NewYork..
- [3] Whited, G.M., Feher, F.J., Benko, D.A., Cervin, M.A., Chotani, G.K., McAuliffe, J.C., La Duca, R.J., Ben-Shoshan, E.A., Sanford, K.J., 2010. Development of a gas-phase bioprocess for isoprene-monomer production using metabolic pathway engineering. *Ind.Biotechnol.* 6, 152-163.
- [4] Ye, L., Lv, X., Yu, H. (2016) Engineering microbes for isoprene production. *Metab. Eng.* 38, 125-135.
- [5] Sharkey, T.D., Yeh, S., Wiberley, A.E., Falbel, T.G., Gong, D., Fernandez, D.E., 2005. Evolution of the isoprene biosynthetic pathway in kudzu. *Plant Physiol.* 137, 700-712.
- [6] Miller, B., Oschinski, C., Zimmer, W., 2001. First isolation of an isoprene synthase gene from poplar and successful expression of the gene in *Escherichia coli*. *Planta* 213,483-487.
- [7] Sasaki, K., Ohara, K., Yazaki, K., 2005. Gene expression and characterization of isoprene synthase from *Populus alba*. *FEBSLett.* 579, 2514-2518.