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BIOLOGICAL PRODUCTION OF MOTH PHEROMONES IN CELL AND PLANT FACTORIES.

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The need for insect pheromones for pest control is increasing. Although synthetic insect pheromones can be produced in large volumes and used for mating disruption of insect pests to protect crops, the high cost of organic synthesis provides an obstacle for increasing the number of target insects and applications. Microbial cell factories as well as plants have been suggested as platforms for biological production of these high-value fine chemicals. Many moth sex pheromones are blends of modified fatty acids in the form of aldehydes, alcohols and acetates. By expressing the necessary and sufficient biosynthetic genes of insect and plant origin, we have made yeast and plants produce unsaturated fatty alcohols and acetates that are common moth pheromone compounds, as well as their fatty acid precursors. As a proof of concept, we co-expressed a Δ11 desaturase and a FAR in the Brewer' s yeast *Saccharomyces cerevisiae* and produced (*Z*)-11-hexadecenol. In the *OLEFINE* project (OLEaginous yeast platforms for FINE chemicals, http://olefine.eu/) we develop novel technology for inexpensive biological production of pheromones from *Yarrowia lipolytica* in bioreactors. Another option is a plant factory, using genetically modified plants for production of pheromones. Using *Nicotiana benthamiana* as a platform, we produced 14C and 16C moth sex pheromone components by transient expression of up to four genes coding for consecutive biosynthetic steps. In the project *Oil Crops for the Future* we have produced genetically modified stable lines of the oil seed plant *Camelina sativa* that produce as much as 30% of selected pheromone fatty acid precursors. The isolated target precursors were reduced to fatty alcohols that were either used directly, oxidized to the corresponding aldehyde or acetylated. To validate the biological activity of the seed oil-derived compounds, we formulated sex pheromone baits for the diamondback moth, *Plutella xylostella*. Field trapping experiments revealed that the *Camelina*-derived pheromone is as attractive as conventionally produced pheromone.