INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP

Plant Oxylipins and Lipid Transfer Proteins in Defense
- It's all about the fat

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Abstract

Oxylipins, the oxygenated metabolites of polyunsaturated fatty acids (PUFAs), are found in many eukaryotic organisms. In plants, several enzymes can produce different types of oxylipins, and the chloroplast structural galactolipids mono- and digalactosyl diacylglycerol (MGDG and DGDG, respectively) are examples of sources of substrate PUFAs. In the model plant *Arabidopsis thaliana*, complex oxylipins known as arabidopsides are formed in response to different types of damage and pathogen elicitation. Similar substances known as linolipins are found in flax (*Linum usitatissimum*). If such substances are formed from free intermediates or directly from fatty acids esterified to complex lipids has been a matter of debate. The synthesis pathways of these substances were therefore investigated and the results show that the fatty acids remain esterified to the glycerol backbone during synthesis of arabidopsides (**Paper I**). It is also shown that all of the synthesis steps in Arabidopsis are enzyme catalyzed (**Paper II**). Formation of complex oxylipins could differ between plant species, but similar experiments on flax indicate that linolipins may also be formed from fatty acids bound to complex lipids. MGDG can have a fatty acid esterified to the galactose molecule, and in some plants, like Arabidopsis, this can be the oxidized fatty acid 12-oxo-phytodienoic acid (OPDA). It was investigated how common these lipids are in different plants, and what enzymes are involved in their synthesis. Samples from representative species of land plants were collected and screened, and non-oxidized acyl-MGDG were found to be omnipresent, while galactolipids with OPDA only exists in a few genera (**Paper III**). A protein responsible for this type of acyl transfer was identified in oat (*Avena sativa*), and an orthologue gene in Arabidopsis, that was named *AGAP1*. Knockout of the gene in Arabidopsis reduced the production of oxidized and non-oxidized acyl-MGDG to almost zero. *In vitro* experiments with protein expressed and purified from *E. coli* showed that the protein was able to catalyze MGDG acylation (**Paper III**). Investigations into the hypersensitive response (HR) in Arabidopsis revealed that the lipoxygenase LOX2, the enzyme responsible for the oxygenation of fatty acids in the arabidopside pathway, is involved in the initiation of the HR programmed cell death induced by effector triggered immunity (ETI). Mutant *lox2* plants had a delayed cell death response to *Pseudomonas syringae* pv. *tomato* (*Pst*) (**Paper IV**). Lipid transfer proteins (LTPs) are small proteins that can bind various lipids and non-polar molecules. Some of the lipid transfer proteins with a glycosylphosphatidylinositol (GPI)-anchor (LTPGs) were found to be involved in pre-penetration resistance against *Blumeria graminis* f. sp. *hordei* (*Bgh*), but not against the non-host mildew *Erysiphe pisi* (*Ep*) (**Paper V**). The reasons could be that fewer protecting or supporting substances that should end up in the protecting papilla are missing or less concentrated in the mutant plants.