The dynamic plant cell membrane;
lipid metabolism and membrane function in response to varying environmental conditions

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Since plants are highly dependent on the structure and thereby the functionality of their cell membranes, alterations in membrane lipid composition is an important part of stress acclimation. Acclimation to drought stress in oat is reflected in the plasma membrane, where the PC (phosphatidylcholine)/PE (phosphatidylethanolamine) ratio is lowered, sterols are increased and cerebrosides decreased. These modifications affect membrane flexibility during a stress situation. Vesicles prepared from plasma membrane lipids of acclimated plants displayed higher permeability to glucose compared with control material, suggesting some instability. On the other hand, in vivo measurements showed lowered ion leakage and prolonged turgor in acclimated plants. It was shown that the lowered PC/PE ratio was mainly caused by increased de novo synthesis of PE from phosphatidylserine decarboxylation via the CDP-DAG pathway.

In oat plants exposed to phosphate starvation stress, a substantial part of plasma membrane phospholipids were replaced by the galactolipid DGDG. Despite this large exchange, the plants were able to proceed in their development, although at a reduced rate. Vesicles prepared from plasma membrane lipids of –P plants, were more permeable to glucose than the controls. During phosphate deficiency, phospholipids are degraded to release phosphate. In the oat plasma membrane, a phospholipase D and a PA phosphatase activity were detected. These two enzymes act to release phosphate and to produce DAG.

Plasma membranes isolated from pea leafs, were shown to contain a lysophospholipid acylating activity. The acyl units of Acyl-CoA:s were preferably incorporated into lyso-PC, and the enzyme was shown to have properties related to lyso-PC acyltransferase (LPCAT). The acylating activity was slightly enriched in a light membrane fraction separated from purified plasma membranes, tentatively denoted as a PAM (plasma membrane associated membrane), where the ER and the plasma membrane are in close contact. It is believed that the ER forms such structural connections not only with the plasma membrane, but also with mitochondria and chloroplasts, and that these regions are important for lipid biosynthesis and transport.

To summarize, this work highlights the dynamic nature of plant cell membranes with focus on lipid metabolism in plant plasma membranes, during favourable conditions or in response to sub-optimal environmental conditions. We demonstrate that alternative metabolic routes, activated during stress or stress acclimation, lead to changes in cell membrane structure and functionality, and thereby increased chances for plant survival.

Key words: drought stress acclimation, phosphate deficiency, phospholipids, galactolipids, plasma membrane, permeability, synthesis

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