Role of Lipids in Pollen Germination and Tube Growth

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Pollen germination and tube growth are critical for successful double fertilization, which is important for sexually propagated seed production in higher plants. Upon landing on stigma surfaces, dehydrated pollen grains receive signals from the stigma via intensive cell-to-cell interactions that trigger pollen hydration, pollen tube emergence, and growth. Pollen activity and longevity, both important factors for successful fertilization and seed set, diminish after anther dehiscence. Stigma exudate (SE), an extracellular secretion covering the outermost surface of stigma, is critical for pollen capture, adhesion, and germination through its stickiness and surface tension. Our study shows that SE of Easter lily (Lilium longiflorum) markedly stimulates pollen germination. Mature pollen grains harbor numerous lipid droplets essential for pollen germination. We speculated that SE might stimulate lipid metabolism to promote pollen germination and pollen tube elongation. To evaluate this hypothesis and explore which types of lipids are altered in response to SE treatment, we investigated lipid profiles during pollen germination by thin layer chromatography (TLC). We found that SE significantly induces degradation of polar lipids including phosphatidylinositos (PIs) and phosphatidylcholines (PCs), but not neutral lipids such as sterol esters, triacylglycerols (TAGs) and sterols. Liquid chromatography-tandem mass spectrometry (LC-MS) and inhibitor assays further suggest that SE treatment enhanced the accumulation of diacylglycerols (DAGs) through a PC-PLC-mediated pathway. DAG is phosphorylated into phosphatidic acid (PA) to stimulate calcium uptake by germinating pollen grains, ultimately stimulating pollen germination and pollen tube growth.