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Legume embryos develop in a hypoxic environment

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Abstract:

Specific morphological and biochemical characteristics of seeds can cause oxygen deficiency within maternal and embryonic tissues. In this study, optical sensors were used to measure O_2 profiles across developing seeds of *Vicia faba* and *Pisum sativum* and developmental and environmental modulations of internal O_2 levels were studied. In addition, the metabolic state of developing embryos was analysed by monitoring adenylate enery charge, adenylate nucleotides and the levels of nucleotide sugars. Within the seed coat O_2 concentration decreased sharply to ~3% towards the inner border. Lowest O_2 levels were detected within the endospermal cavity between the seed coat and embryo. It is probable that low seed coat permeability provides a hypoxic environment for legume embryo development. The O_2 concentration in embryonic tissue changed during development with the lowest levels in the early stages. Measured in darkness, the levels were below 3%, but increased upon illumination indicating that photosynthesis significantly contributes to internal O_2 levels. Only in very young embryos were ATP levels and energy charge low. Otherwise they were maintained at a constant higher value. ADP-glucose and UDP-glucose did not show large fluctuations. Throughout embryo development fermentative activity did not play a major role. Obviously, specific mechanisms prevent seed tissues from becoming anoxic during development. The possible role of low oxygen on seed metabolism and on the control of seed development in legumes is discussed.

Key-words: Energy charge, hypoxia, optical oxygen sensors, photosynthesis, seed development