

Table 1. Overview of the current knowledge on oxygen availability within seeds and its effect on metabolic fluxes

The internal seed oxygen concentrations as given in this table are all measured in the light. The data on the effect of oxygen on metabolic fluxes indicate a decrease (↓), increase (↑), or no change (=) in the incorporation of radioactive label from ^{14}C Suc fed to the tissue while seeds were treated with air containing different oxygen concentrations. Note that the flux experiment on broad bean was performed in darkness in order to reduce internal oxygen. N.d., Not determined. References: (1) Rolletschek et al. (2002); (2) Rolletschek et al. (2003); (3) Borisjuk et al. (2003); (4) Gibon et al. (2002); (5) Vigeolas et al. (2003); (6) Rolletschek et al. (2004); (7) this study.

Species	Subclass	Main Storage Products	Chlorophyll Present?	Internal $[\text{O}_2]$ at Ambient Air in the Light	Flux at Reduced Internal O_2	Flux at Increased Internal O_2	Remarks	References
Pea	Dicot	Starch, protein	Yes	10 %	N.d.	N.d.	Seed photosynthesis has been shown to contribute significantly to the oxygen supply within the seed.	1, 2
Broad bean	Dicot	Starch, protein	Yes	4–10	Starch ↓ at 0.1% O_2 Protein = at 0.1% O_2	N.d.	Protein synthesis is mainly located in the outer region, where oxygen, and ATP are relatively high. Starch synthesis dominates in the inner region of the seed, where oxygen and ATP concentrations are lowest.	2, 3
Arabidopsis	Dicot	Oil, protein	Yes	N.d.	Lipid ↓ at reduced external O_2 Protein ↓ at reduced external O_2	N.d.	Seed metabolism adapts to reduced oxygen in order to save energy and thereby oxygen.	4
Rapeseed	Dicot	Oil, protein	Yes	0.8	Lipid ↓ below 0.8% O_2 Protein ↓ below 0.8% O_2	Lipid ↑ above 0.8% Protein ↑ above 0.8%	The oxygen supply of seeds under normal conditions is strongly limiting for seed metabolism.	5
Barley	Monocot	Starch Protein	In the pericarp, but not in the endosperm	0.2	N.d.	N.d.	ATP levels and internal seed oxygen correlate with each other, both in a temporal and a spatial manner.	6
Wheat	Monocot	Starch, protein	In the pericarp, but not in the endosperm	2.1	Starch ↓ at 0.5% O_2 Protein ↓ at 0.5% O_2	Starch = above 2.1% O_2 Protein = above 2.1% O_2	Using noninvasive ^{11}C -labeling of assimilates, the internal oxygen concentration within seeds is shown to affect phloem import via a reduction of metabolism.	7