Seed survival in the dry state

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In many ways, most seeds may be considered 'extremophiles'. In the dry state they can survive extreme conditions, such as high and low temperatures and drought, for extended periods of time. This group of desiccation tolerant (orthodox) seeds possesses mechanisms to protect their vital functions, which may readily be reinitiated upon hydration. These mechanisms have been the subject of many studies. It is now known that a controlled repression of primary metabolism, cell cycle and gene expression, upon drying, is key to these mechanisms. In addition, protective substances are being formed that interact with macromolecules to prevent their inactivation by denaturation, unfolding or aggregation during drying. The LEA proteins form one of the most important groups of these protective compounds. They are considered chaperones because of their properties that effectuate association with vital macromolecules, such as DNA, proteins and membranes. Membrane structure may be preserved by a combination of LEAs with sugars in so called 'glasses'. Desiccation tolerance is by itself not sufficient to guarantee long time survival in the dry state. The gradual loss of viability of seeds during dry storage appears to depend, to a large extend, on the ability to preserve anti-oxidant activity. Anti-oxidant activity is required to prevent damage by reactive oxygen species, during storage and upon rehydration. An overview will be given of recent progress in this field on the elucidation of these mechanisms. In addition, original data will be presented on physico-chemical markers of seed survival in the dry state. These markers were identified by electronic paramagnetic resonance and nuclear magnetic resonance techniques. They correlate well with the progression of viability loss in a number of seeds. The markers are associated with properties of membrane and cytoplasm, as well as with redox state of embryonic cells.