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Transcript Profiling of the Anoxic Rice Coleoptile

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Higher plants are aerobic organisms that rapidly die when oxygen availability is limited due to flooding of the soil. Species originating from semi-aquatic environments can, however, cope with flooding stress. They can survive complete submergence for weeks and some even have the capacity to grow vigorously and produce flowers and seeds in permanently water-saturated soils. A well-known crop example in this context is rice that produces high yields even when grown in waterlogged rice paddies. The molecular mechanisms allowing rice to elongate the coleoptile under complete oxygen absence, a behavior not observed in any of the other cereals, are largely unknown. In the present work we present the transcript profiling of the anoxic rice coleoptile compared to its aerobic counterpart. The data demonstrate that beside several genes similarly regulated in both rice and Arabidopsis, genes specific of the anaerobic response of rice can be identified, revealing clues about their regulation. Most of the genes encoding glycolytic enzymes show enhanced mRNA accumulation and, interestingly, genes involved in pyruvate metabolism are strongly upregulated. The strong expression of alpha-amylase (*RAmy3D*) indicates that starch degradation plays a role also in the anoxic coleoptiles. The induction of *RAmy3D* under anoxia is however completely abolished when the coleoptiles are incubated in the presence of exogenous glucose, indicating that anoxia induces this gene indirectly, as a consequence of a drop in the sugar content of the coleoptile. Coleoptile elongation under anoxia is due to cell expansion and expansins likely play a major role in this process. Expansin genes are mostly down regulated under anoxia, but an exception to this trend is represented by *EXPA7*, that is more expressed under anoxia than in air. HSPs may play a role in anoxia tolerance and several genes coding for HSPs are indeed induced in the anoxic coleoptile. The mRNA level of several ERF-like is enhanced by anoxia both in the anoxic rice coleoptile. This is of importance, since the *Sub1* gene in rice, responsible for submergence tolerance in adult plants encode an ERF-like protein (Fukao *et al. Plant Cell* 2006). Overall the results indicate that the transcriptional profile of the coleoptile is dramatically altered by anoxia. Several genes appear to be upregulated by the anoxia-driven sugar starvation rather than by low oxygen itself. These results represent the first available profiling of the anoxic rice coleoptile, revealing previously unknown aspects if the anaerobic response.