Crystal Structure of a Eukaryotic FeSOD Suggests Intersubunit Cooperation during Catalysis

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Superoxide dismutases (SODs) are a family of metalloenzymes that catalyze the dismutation of superoxide anion radicals into molecular oxygen and hydrogen peroxide. Iron superoxide dismutases (FeSODs) are only expressed in some prokaryotes and plants. A new and highly active FeSOD with an unusual subcellular localization has recently been isolated from the plant Vigna unguiculata (cowpea). This protein functions as a homodimer and, in contrast to the other members of the SOD family, is localized to the cytosol. The crystal structure of the recombinant enzyme has been solved and the model refined to 1.97 Å resolution. The superoxide anion binding site is located in a cleft close to the dimer interface. The coordination geometry of the Fe site is a distorted trigonal bipyramidal arrangement, whose axial ligands are His43 and a solvent molecule, and whose in-plane ligands are His95, Asp195, and His199. A comparison of the structural features of cowpea FeSOD with those of homologous SODs reveals subtle differences in regard to the metal–protein interactions, and confirms the existence of two regions that may control the traffic of substrate and product: one located near the Fe binding site, and another in the dimer interface. The evolutionary conservation of reciprocal interactions of both monomers in neighboring active sites suggests possible subunit cooperation during catalysis.

Keywords: crystal, metalloenzyme, FeSOD