Crystal Structure of Rice Rubisco Complexed with NADPH

Taketo Ogawa[a], Hiroyoshi Matsumura[a], Hiroyuki Ishida[b], Ayako Kogami[a], Eiichi Mizohata[a], Amane Makino[b], Tsuyoshi Inoue[a], Tadahiko Mae[b], Yasushi Kai[a], *[a]Department of Materials Chemistry, Graduate School of Engineering, Osaka University, Japan. [b]Department of Agricultural Chemistry, Graduate School of Agriculture, Tohoku University, Japan.* E-mail: taketo@chem.eng.osaka-u.ac.jp

Ribulose 1,5-bisphosphate carboxylase/oxygenase (Rubisco) catalyzes the carboxylation of ribulose 1,5-bisphosphate (RuBP) in the initial step of the photosynthesis. It can also catalyzes the oxygenation of RuBP in photorespiration. To exhibit carboxylation and oxygenation, Rubisco must be activated via the covalent carbamylation of a specific lysine residue on the active site and subsequent stabilization of the carbamate by Mg^{2+} coordination. This process is known to be relatively slow, and be modulating the activity of Rubisco. Evidence has been obtained for the role of several sugar phosphates as important regulators of the carbamylation of Rubisco. Both RuBP and 2-carboxyarabinitol 1-phosphate (CA1P) are reported to be potent inhibitors, whereas NADPH and 6-phosphogluconate accelerate the carbamylation of Rubisco [1]. To investigate the NADPH-accelerated carbamylation mechanism of Rubisco, we have crystallized the Rubisco from rice (Oryza sativa L.) under the condition similar to that in the stroma. Here, we report the 1.8 Å crystal structure of the rice Rubisco complexed with NADPH and Mg^{2+} as well as the 1.4 Å structure complexed with Mg^{2+}. The high resolution structures indicate the detailed active site, in which Mg^{2+} and its ligand waters were stabilized by the interaction with NADPH. These observations probably suggest that the activation upon NADPH binding is induced by both increases in the accessibility of the active site and decrease in the rate of deactivation.

[1] *Ann. Rev. Plant Physiol.,* 1977, **28**, 379.

Keywords: crystal structure determination, photosynthesis, activity and mechanism of enzymes