No. 0825

Molecular Basis of Biomimetic Nano-Technology for Controllable Crystallization of Calcium Carbonate

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Summary

Calcified hard tissues and skeletons, such as various shells and pearls, provide structural support and protection for many marine invertebrate phyla. Calcified shell layer is composed of two polymorphs of calcium carbonate, aragonite or calcite, and an organic matrix. The organic matrix is though to function in shell formation (biomineralization) by determining structural properties such as crystal type, size and shape. The matrix, which consists of various proteins, polysaccharides and proteoglycans, can be separated into soluble and insoluble fractions. In this study, the modulating effect of invertebrate lectins, and organic matrices on the crystallization of calcium carbonate was investigated. The multiple C-type lectins isolated from the acorn barnacle, *Megabalanus rosa*, inhibited the nucleation and growth of calcium carbonate crystals. The crystals of aragonite and calcite were formed in the presence of lower concentrations of lectins. The morphology of the crystals was examined by optical, electron, confocal, and FT-IR spectroscopy.

Microstructure and orientation distribution of aragonite crystals in the nacreous layer of *Pteria penguin* shells were examined. Helical patterns drawn by growth forefronts of the nacreous layer were observed by a laser microscope for good-quality shells, whereas no clear pattern was observed for bad-quality ones. The aragonite crystals in the nacreous layer of the good-quality shell seem to be harminocally oriented along a crystallographic direction. Novel lectins, PPL-1 and PPL-2, were isolated from the mantle of *Pteria penguin* by affinity chromatography and cation exchange chromatography. PPLs showed sequence homologies to unique lectin families and characteristic sugar-binding specificities. PPL-2 was detected in the organic matrix of the shells.

The obtained findings indicate that lectins play an important role in biomineralization as organic matrix components and can be applied to artificial crystallization in the sect of nanotechnology.