Grounds for winning the 2014 Society Award of the Japan Society for Cryobiology and Cryotechnology

Cryobiological and Cryotechnological Research from the Standpoint of Physicochemistry of Water

By Dr. Osato Miyawaki (Professor of Ishikawa Prefectural University)

Dr. Osato Miyawaki graduated and received Dr. degree from the University of Tokyo (UT) in 1974. After that, his academic carrier started from an assistant professor in UT, a visiting assistant professor in University of Pittsburgh, and then he came back to UT as an associate professor in 1988. In 2005, he became a full professor in Ishikawa Prefectural University. He joined our society in 1985. Since then, he was actively involved in the various activities of the society though his many academic contributions as well as managements as a director, an editor-in-chief, and the president.

Dr. Miyawaki proposed a theory that explains the ice crystal size (d_P) formed in frozen food to be inversely proportional to the advance speed of the freezing front of ice (u) with a proportional constant in the order of water diffusion coefficient (D_W). This is an important finding to analyze and control ice crystal structure in frozen food.

In the freezing of living cells, an extracellular freezing generally occurs prior to an intracellular freezing, which causes cell dehydration through the freeze-induced osmotic dehydration. As the intracellular freezing causes a fatal damage on the cell, the rapid dehydration is important during the extracellular freezing stage. Dr. Miyawaki found out the importance of the combined parameter L_P/d_P (L_P, water permeability of membrane; d_P, cell size) as a parameter to determine the dehydration rate of cells. He measured and compared this parameter among microorganism, animal, and plant cells

to find out that the plant cell has the lowest L_P/d_P value among those. This explains the difficulty in the freezing preservation of plant cells compared with other cells.

Freeze concentration has been known as the best method for high-quality concentration of liquid food. However, the conventional method, suspension crystallization, is very complex and highly expensive so that this method is not widely used in practice. On the contrary, Dr. Miyawaki proposed a new method, progressive freeze-concentration, in which a single ice crystal is formed on the cooling plate. This method makes the system much simpler so that a substantial cost reduction is expected in freeze concentration. A project is now going on to apply this method in practice.

He, recently, proposes a new theory on the role of hydration in protein stability. In this approach, the unfolding ratio of a protein is directly correlated to the water activity (aw) of the system. This shows the important role of hydrogen-bondings among amino acid residues as well as the hydrophorbic interaction in protein stability. This clearly explains the important role of aw in protein stability, which has been neglected for the long time in the literature. This theory is expected to bring about a new break-through in the basic understanding of the marginal stability of proteins.

Thus, Dr. Miyawaki made a remarkable contribution to our society through his original activities on cryobiological and cryotechnological research from the standpoint of physicochemistry of water. Therefore, he deserves the 2014 Society Award of the Japan Society for Cryobiology and Cryotechnology.