A Novel Protein Modifying Enzyme : Protein-Glutaminase

Protein is an important ingredient in food systems. In addition to the nutritional benefit, protein contributes to the textural and sensory properties of food. For instance, egg white protein is an excellent foaming agent in bakery products and the gelling property of milk protein is utilized for cheese and yogurt making. These properties are referred to as "protein functionality" (Table). An improvement in the functionality of under utilized plant proteins such as wheat and corn gluten would expand their usefulness to the food industry and because these proteins are widely available in large quantity any increase in food applications would have a positive impact on feeding the world's population.

The enzymatic modification of proteins is a promising method for improving protein functionality because it is highly specific and compared to the chemical modification process is environmentally friendly. Limited proteolysis, utilizing proteases from animal, plant and microbial sources, has been widely used for this purpose. The use of chymosin in cheese making, one of the oldest and best-known examples of enzyme utilization in human history, can be classified in this category. Recently a microbial transglutaminase (protein cross-linking enzyme), first discovered by the R&D group at Amano Enzyme Inc. and now being commercialized with the collaboration of Ajinomoto Co., Inc., has had a significant impact on the food protein industry.

Amano has continued to search for new types of protein modification enzymes. An extensive screening effort for potential enzymes has resulted in the discovery of a novel protein-deamidating enzyme (*Appl. Environ. Microbiol.*, **66**, 3337 (2000)). The enzyme converts the glutaminyl residues in protein to glutamyl residues and is called protein-glutaminase (*Eur. J. Biochem.*, **268**, 1410 (2001)). More than 95% of the glutaminyl residues of some food proteins, such as milk casein and wheat gluten, are deamidated by this enzyme. The isoelectric point of deamidated protein is lowered as a result of the increase in negatively-charged carboxyl groups; the product is a protein with good solubility at the more acidic pH of many food systems. Protein deamidation also causes an alteration of the protein folding structure due to the newly formed negative charges. This unfolding leads to exposure of hydrophobic regions, resulting in a protein with improved amphiphilic character that would make deamidated protein an ideal emulsifier or foaming agent. In addition to improvement in protein functionality, protein-glutaminase can be used for many applications in the food industry, including dough softening in the baking industry, enhancement of umami taste (glutamic acid) in hydrolyzed vegetable protein, and increase protein digestibility (Patent No. EP0976829A2). This novel enzyme will be commercialized by Amano in the near future.

Table. Protein Functionality in Food Systems

Functionality	Protein type	Food
Solubility	Whey proteins	Beverages
Viscosity	Gelatin	Soups, gravies, salad dressings, desserts
Water binding	Muscle and egg proteins	Meat sausages, cakes, breads
Gelation	Muscle, egg and milk proteins	Meats, gels, cakes, bakeries, cheese
Emulsification	Muscle, egg and milk proteins	Sausages, bolongna, soup, cakes, dressings
Foaming	Egg and milk proteins	Whipped toppings, ice cream, cakes, desserts

Improvement of protein functionality