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PERSPECTIVES OF MICROBIAL TRANSGLUTAMINASE IN MEAT PROCESSING

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Introduction

In the meat industry, small skeletal muscles and trimmings are usually processed to minced meat products, sausages, highly comminuted meat products and snacks. This means that small pieces of high quality are after processed into products with a relative low economic value. The availability of these small meat pieces and trimmings has an increasing tendency with the development in slaughtering and cutting techniques, which are characterised by an increasing of mechanization and automation.[1] Therefore, research has been stimulated and focused on the method to maximize yield of marketable high-value products from small cut and trimmings. This includes the development of methods of restructuring small cuts and trimmings to improve appearance, texture and market value[2]. For such a restructuring process, there are several alternatives such as chemical and enzymatic treatment. However, considering product safety, consumer appreciation and governmental regulations, enzymatic methods are more acceptable and have therefore more potential[1,3].

Among enzymes used for meat restructuring, transglutaminase is the one which has been extensively studied. The idea of using transglutaminase for meat restructuring was inspired by the "setting phenomenon" in surimi. The so-called "setting phenomenon", formation of strong and cohesive gels at low temperature, was proved to be the function of transglutaminase[2,4,5]. Wijngaards and Paardekooper used transglutaminase from bovine plasma for the production of composite meat products[1]. Kim *et al.* reported the polymerization of meat actomyosin by transglutaminase from *Guinea Pig* liver[2]. Several patent applications have also been claimed recently in this field.

Transglutaminase

Transglutaminase (glutaminyl-peptide γ-glutamyltransferase, EC 2. 3. 2. 13) is an enzyme capable of catalyzing acyl transfer reaction to introduce covalent cross-links between proteins[6], as well as peptides and various primary amines. When the ε-amino groups of lysine residues in proteins act as an acyl-acceptor, ε-(γ-Glu)-Lys bonds are formed both intra- and inter-molecularly. In the case without primary amine in the reaction system, water becomes the acyl-acceptor and the γ-carboxyamide groups of glutamine residues are deaminated, becoming glutamic acid residues. A schematic illustration of the transglutaminase catalyzed reactions is shown in Figure 1.

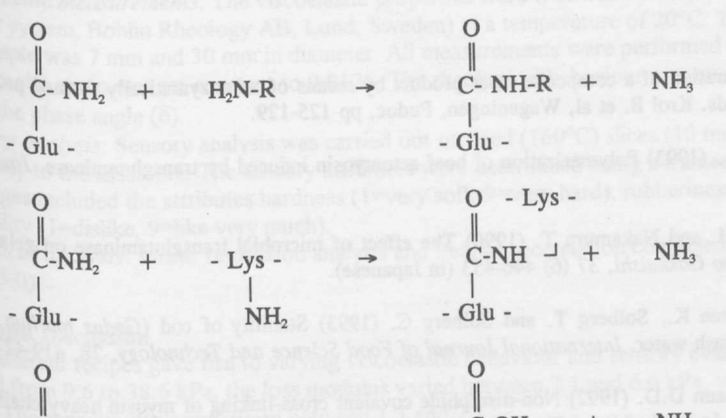

Figure 1. Transglutaminase catalyzed reactions[7]

Transglutaminase can be found in nature from animal tissue and liquid, plant tissue and microorganisms. Historically, animal tissues, mainly *Guinea Pig* liver, is the sole source of obtaining transglutaminase. The scarce source and complicated separation and purification procedure result in an extremely high price of the enzyme, which limits its wide application in meat processing.

Prospects of microbial transglutaminase

The possible alternatives of production of transglutaminase are shown in Figure 2. It seems to be impractical and uneconomical to obtain transglutaminase from animal and plant tissues due to high cost. Recently, studies on production of transglutaminase by microorganisms have been explored. However, the research is limited in certain laboratories although microbial process provides the opportunity of mass production efforts have to be made before this enzyme can be applied to meat processing in an industrial scale. Up to now, thousands of strains have been already screened for transglutaminase productivity[8]. The number of transglutaminase producing strain is very low. To improve productivity through genetic engineering seems to be impractical in a short term, due to objections of consumer to genetically engineered organisms[9]. Therefore, the process technology improvement in conventional fermentation will be now the way to realize the mass production of transglutaminase with reasonable and acceptable cost[10].

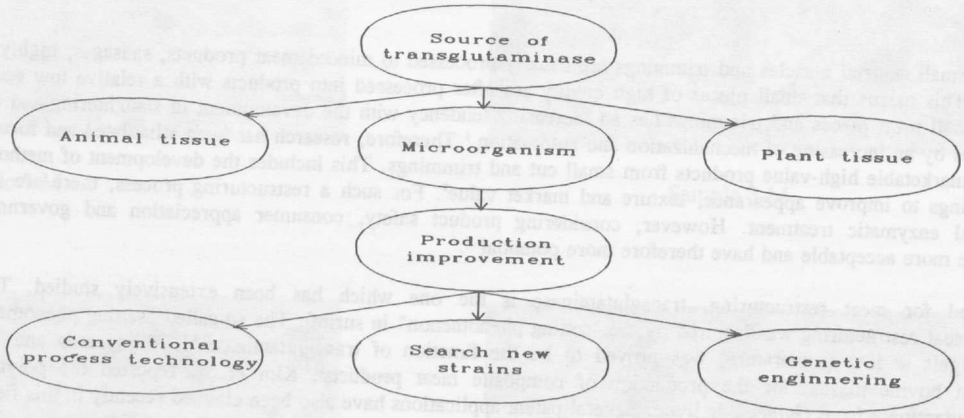

Figure 2. Overview of transglutaminase production

Reference

1. Wijngaards G. and Paardekooper E.J.C. (1988) Preparation of a composite meat product by means of an enzymatically formed protein gel. In "Trends in modern meat technology", Vol 2, eds. Krol B. et al, Wageningen, Pudoc, pp 125-129.

2. Kim S.H., Carpenter J.A., Lanier T.C. and Wicker L. (1993) Polymerization of beef actomyosin induced by transglutaminase. *Journal of Food Science*, 58 (3), 473-474, 491.

3. Mugumura M., Sakamoto K., Numata M., Yamada H. and Nakamura T. (1990) The effect of microbial transglutaminase on gelation of myosin B, myosin and actin. *Nippon Shokuhin Kogyo Gakkaishi*, 37 (6) 446-453 (in Japanese).

4. Ofsatd R., Grahl-Madsen E., Gundersen B., Lauritszen K., Solberg T. and Solberg C. (1993) Stability of cod (*Gadus morhua* L.) surimi processed with $CaCl_2$ and $MgCl_2$ added to the wash water. *International Journal of Food Science and Technology*, 28, 419-427.

5. Kamath G.G., Lanier T.C., Foegeding E.A. and Hamann D.D. (1992) Non-disulphide covalent cross-linking of myosin heavy chain in "setting" of alaska pollock and atlantic croaker surimi. *Journal of Food Chemistry*, 16, 151-172.

6. Nonaka M., Tanaka H., Okiyama A., Motoki M., Ando H., Umeda K.and Matsura A. (1989) Polymerization of several proteins by Ca^{2+}-independent transglutaminase derived from microorganism. *Agricultural and Biological Chemistry*, 53 (10), 2619-2623.

7. Ikura K. (1988) Studies on use of transglutaminase. *Nippon Nogeikagaku Kaishi* 62 (10), 1451-1461 (in Japanese).

8. Ando H., Adachi M., Umeda K., Matsura A., Nonaka M., Uchio R., Tanaka H. and Motoki M. (1989) Purification and characteristics of a novel transglu-taminase derived from microorganisms. *Agricultural and Biological Chemistry* 53 (10), 2613-2617.

9. Jank B. (1995) Biotechnology in European society. *Trends in Biotechnology*, 13, 42-44.

10. TNO (1995) Novel fermentation process for microbial transglutaminase production. Patent application, (in preparation).