A potential harmless food bio-preservative — pediocin PA-1

Food safety issues are always around us for food-borne pathogen and spoilage bacteria exist in many kinds of food. Chemical preservatives are added to prevent food spoilage, however, most of them are cancerogen and unsafe for us. Is there some subsititutes which act as safe preservative? Yes, bacteriocins can do this.

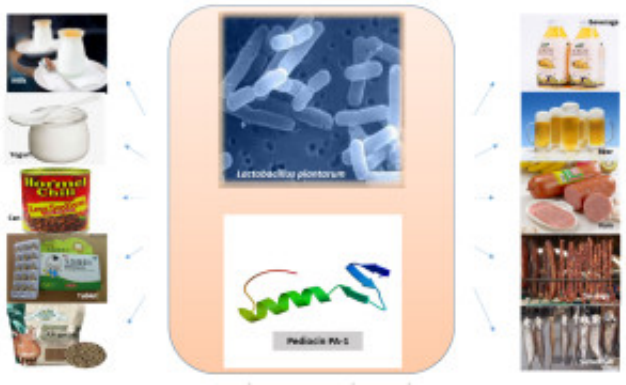

Fig. 1. Pediocin PA-1 and its application.

Bacteriocins are antimicrobial peptides synthesized by ribosome. They can inhibit the growth of similar or closely related bacterial strains. However, the bacteriocin producing strains protect themselves by producing related immunity proteins. Bacteriocins produced by lactic acid bacteria are generally divided into two groups: class I called lanthionine-containing bacteriocins and class II called non-lanthionine-containing bacteriocins. One type of the second group, class IIa bacteriocins, are of great interest for their applications as probiotics, food preservatives and potential infection treatments. They can act as additives into many kinds of food without any harmless side-effect, such as milk, beverage, beer, sausage and feed. Pediocin PA-1, produced by *Lactobacillus plantarum*, is a well-known class IIa bacteriocin which shows strong inhibitory effect against *Listeria monocytogenes*.

The pediocin PA-1 molecule consists of two parts: an 18 amino acid residues signal peptide and a 44 amino acid residues mature peptide. The mature peptide formed into a conserved and ?-sheet-like N-terminal half and a helix-containing C-terminal half. The model of pediocin PA-1 killing bacteria cells is studied a long time but insufficient demonstrated. Pediocin PA-1 performs its function by permeabilizing the cytoplasmic membrane of the receptor bacteria, which resulting a leakage of ions and small molecules. Previous studies have demonstrated that pediocin PA-1 interacts with its receptor by binding an extracellular loop of the mannose-phosphotransferase system (MPTs) which located in the membrane. In this process, the conserved N-terminal domain of pediocin PA-1 mediates the initial binding with MPTs by electrostatic interaction and then the

hydrophobic C-terminal domain penetrates into the membrane of target cell. The helix structure of C-terminal domain plays a crucial role in receptor membrane leakage. According to this, site-directed mutagenesis was performed to improve the antimicrobial activity of pediocin PA-1 and to elucidate the structure-function relationship and our research was mainly focused on the modification of the helix domain in C-terminal region.

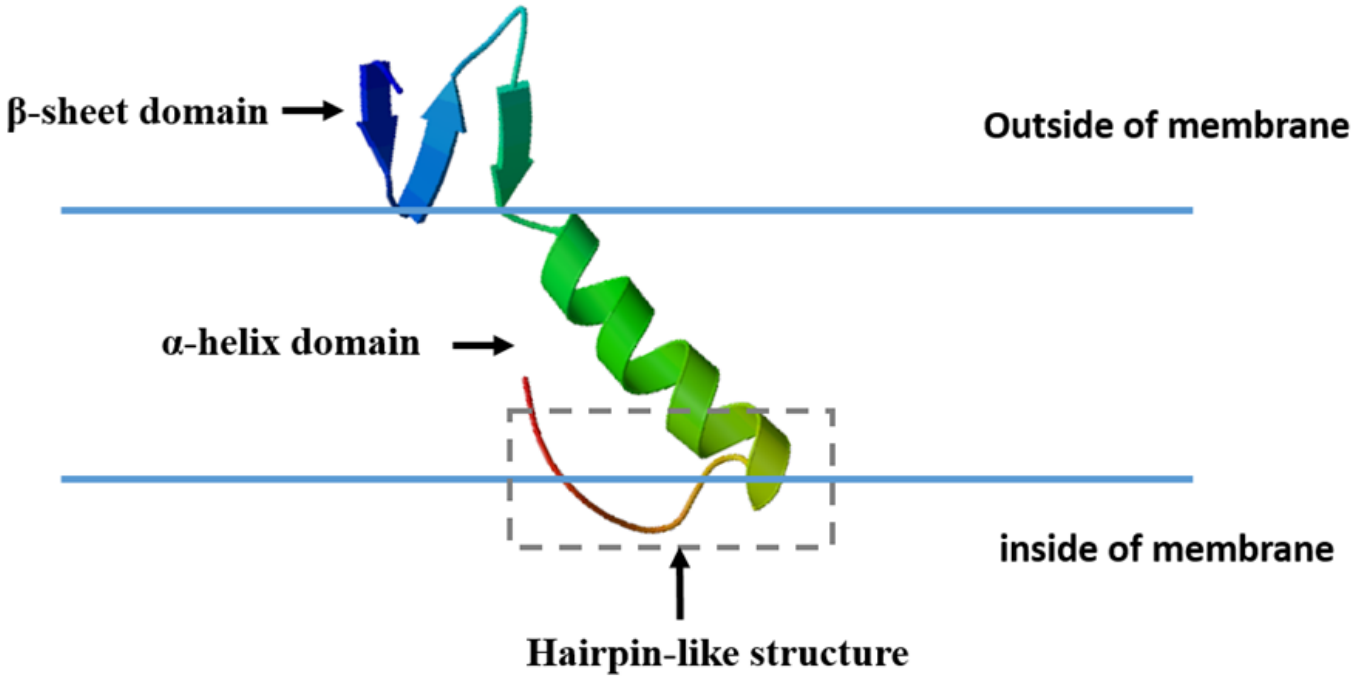

Fig. 2. Model of the insertion of pediocin PA-1 into target membranes.

In the work, fourteen mutants of pediocin PA-1 were constructed and expressed in *Escherichia coli* heterologously. The substitution of glycine in position 29 to alanine showed the most distinct increase of antimicrobial activity and we further demonstrated the importance of the hairpin-like structure. Statistics illustrated that a hydrophobic tip of the hairpin-like domain and a smaller bundle of the ?-helix domain facilitated the penetrating of pediocin PA-1 into a hydrophobic part of the membrane-embedded MPTs at an enormous extent, which mediated the leakage through the target cell membrane and causes the cell death.

Publication

Improvement of Antimicrobial Activity of Pediocin PA-1 by Site-directed Mutagenesis in C-terminal Domain.

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