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Bacteriocins from Bugs of Millennium: Uses, Potential and Prospects in Food Industry

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Abstract

Are Lactic Acid Bacteria the bugs of the millennium? These surely are one of the highly pragmatic bugs of the millennium due to their diversity of metabolism, making them the most important group of bacteria in the production of traditional and modern fermented food products, their potential use in health and disease when used as probiotics or even their effect in protection of food products against microbial contaminants due to the production of acids and bacteriocin. These micro-wonders, the super-edible bugs are the food-grade lactic acid bacteria, with ability to produce bacteriocins. Bacteriocins, also known as antimicrobial peptides (AMPs), are small peptides with anti-bacterial properties, generally produced by both Gram-positive and Gram-negative bacteria. These represent a huge family of ribosomally synthesized proteinaceous molecules that are extracellularly released and heat-stable. These possess remarkable antibacterial activity towards closely related strains and to which the producer cell expresses a degree of specific immunity. Also, sizeable numbers of bacteriocins have been reported to have broad range antimicrobial activity. These antimicrobial peptides have huge dual fold potential: as food preservatives and as next-generation antibiotics targeting the multiple-drug resistant pathogens. Bacteriocins antagonize sensitive cells through different and distinctive mechanisms. Although structure–function relationships have only been determined for particular bacteriocins and to varying degrees, examples of bacteriocins targeting the cell wall, cell membrane, nucleic acids, or enzymes have been established.

There exists difference of opinion on classification scheme because of large number of new bacteriocins that have been identified and characterized and the evolving definition for these antimicrobial peptides. The different classes that can be used are: Class I bacteriocins, or lantibiotics (lanthionine- containing antibiotics), that are small peptides (<5 kDa); and Class II bacteriocins, or the non-lantibiotics, that are small (<10 kDa), heat-stable non-lantibiotics, Class I bacteriocins are often further subdivided into four subclasses: Class IIa — "pediocin-like" bacteriocins, these are found to have high potency against the food pathogen *Listeria monocytogenes*; Class IIb — two-component bacteriocins that require both peptides to work synergistically to be fully active; Class IIc — circular bacteriocins with N- and C-termini covalently linked giving the peptide an extremely stable structure and Class IId — unmodified, linear, non-pediocin-like bacteriocins The (former) Class III group, which included large (> 30 kDa) heat-labile non-lantibiotics, has been proposed to be reclassified as bacteriolysins, since they are lytic enzymes rather than peptides.

Lantibiotics (Class I bacteriocins) like nisin have a relatively broad inhibitory spectrum including a number of different genera of Gram-positive bacteria. Bacteriocin target specificity, like for nisin and circular bacteriocins, has also been described as concentration dependent, with a nonspecific activity at higher bacteriocin concentrations and a specific activity at lower bacteriocin concentrations. This *specific activity at lower bacteriocin concentrations* make bacteriocins often very potent, acting at pico- to nano-molar concentrations, whereas micromolar concentrations are required for the activity of eukaryotic anti-microbial peptides. LAB bacteriocins, besides being a by-product of Generally Regarded as Safe (GRAS) LAB, are especially attractive for various food applications because they are colourless, odourless, tasteless, with tolerance to high thermal stress and are known for their activity over a wide pH range, positive attributes for their possible use as an ingredient in food production. These have huge potential in the biopreservation of various foods, either alone, or in combination with other methods of preservation, as a means of hurdle technology.

Keywords: Lactic Acid Bacteria, antimicrobial peptides, bacteriocins, Lantibiotics