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Popular Article

Bacteriocins and its application in food preservation

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Introduction

Biopreservation is a method of food preservation that employs natural antimicrobials (biopreservatives) and microbiota to extend food storage life. Consumers are increasingly seeking chemical-free foods due to their reported negative effects. Bacteriocins are bactericidal proteins or peptides that can inhibit the development of food- spoiling bacteria. These substances are made by various gram-positive and gram-negative microorganisms, each of which has its own molecular weight, biochemical makeup, and mode of operation. The majority of bacteriocins target an individual bacterial strain or species without disturbing other microbial populations. One solution to solve this issue is the use of bacteriocin (Raichurkar, and Athawale, 2015). Modern food-processing technologies and microbiological food-safety standards have reduced, but not entirely eliminated, the likelihood of food-related illness and product spoilage in industrialised countries. The increasing consumption of precooked food, which is susceptible to temperature abuse, and the continual importation of raw foods from developing countries are two of the primary causes of this situation (Ananou *et al.*, 2007). Food spoilage is the loss of the food's original nutritional value, texture, and flavour, which ultimately makes it unsafe for humans to consume (Nath *et al.*,2014). *Salmonella, Campylobacter jejuni, Escherichia coli 0157:H7, Listeria monocytogenes, Staphylococcus aureus, and Clostridium botulinum* have all been linked to such outbreaks. Food preservation is a never-ending battle against microorganisms that spoil or make food unsafe (Raichurkar, and Athawale, 2015).

Microorganisms and their metabolic by-products have been used for food preservation since prehistory. Lactic Acid Bacteria (LAB) are generally regarded as safe for this application (Hammam *et al.*, 2019). Furthermore, as an alternative to chemical preservatives, natural antimicrobials may be an effective way to prevent or minimise food spoilage and/or foodborne outbreaks. Bacteriocins are a large family of proteinaceous toxins produced by bacteria and Archaea that have antimicrobial activity

against bacteria closely related to the producer strain (Hols *et al.,* 2019). Only a few bacteriocins, in addition to their antibacterial properties, also have antiviral and antifungal properties (Vieco-Saiz, 2019).

Source and analysis of bacteriocins

Bacteriocins derived from Gram-positive bacteria, particularly Lactic Acid Bacteria (LAB), have received extensive research due to their high biosafety and wide range of industrial applications. Bacteriocins are produced by many Gram-positive, Gram-negative, and Archaea bacteria in the bacterial community (Juturu and Wu, 2018). Furthermore, the majority of bacteriocin producers are Lactic Acid Bacteria (LAB), a group which exists naturally in foods and has an extended history of safe use in the dairy industry. Bacterial cells that generate bacteriocins are resistant to their antimicrobial peptides, which are regulated by the host cells' specific immunity proteins. Bacteriocins, whether purified or excreted by bacteriocin-producing strains, are a great alternative to the inclusion of chemical preservatives in dairy products because they pose no health risks (Silva *et al.,* 2018). Bacteriocins, such as nisin, are considered safe for use as a preservation agent for food in vegetables, dairy, meats, and other food products because they inhibit microorganism contamination during the manufacturing process (Owusu-Kwarteng *et al.,* 2020). Bacteriocins generated by one bacterium that are inhibitory to other bacteria of the same species are referred to as narrow-spectrum bacteriocins (Parada *et al.,* 2007).

Effectiveness of bacteriocins in food systems

Bacteriocins inhibit target organisms in broth systems, but further research is needed to confirm their efficacy in food. The chemical formula and food's physical conditions can have substantial effects on the bacteriocin's activity. For example, Nisin at pH 2 is 228 times more soluble than at pH 8. Because lactic acid bacteria are frequently utilised as food starter cultures. Researchers have investigated the use of fermentations. Bacteriocin producers can be used as starter cultures (Ghosh *et al.,* 2021).

Food applications of bacteriocins

Applications in dairy industry: Bacteriocins are widely used in the dairy industry, particularly during product fermentation. Many studies have been conducted to demonstrate the efficacy of nisin and/or nisin-producing strains against pathogenic bacteria like *Clostridium* difficile butylated hydroxyanisole (Raichurkar and Athawale, 2015). Bacteriocins with lytic properties, such as nisin and lacticin 3147, could be used to speed up the ripening of cheddar cheese. Cell lysis of the beginning culture is beneficial for flavour development (Guinane *et al.,* 2005).

Applications in meat products: One must keep in mind that meat and meat products are complex systems with a variety of factors influencing microbial growth and metabolite production when assessing a bacteriocin-producing culture for banger fermentation and/or biopreservation. As a result,

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it is necessary to evaluate how formula and technology for fermentation affect the effectiveness of bacteriocin-producing cultures. The most extensively researched bacteriocins found in meat and meat products are nisin, enterocin AS-48, enterocins A and B, sakacin, leucocin A, and particularly pediocin PA-l/AcH, used alone or in combination with a variety of physicochemical processes, modified atmosphere packaging, high hydrostatic pressure (HHP), heat, and chemical preservatives as an additional barrier to control *L. monocytogenes and other pathogens* (Cleveland *et al.,* 2001; Nielsen *et al*., 1990; Garriga *et al.,* 2002; Ananou *et al.,* 2005a; Ananou *et al.,* 2005b).

Applications in fish

Gram-negative microorganisms are typically responsible for the degradation of fresh fish, but pathogenic organisms like *Clostridium botulinum and L. monocytogenes* can also cause issues in vacuum-packed fresh fish and seafood. Nisin and Microgard together increased the shelf-life and decreased the growth of *L. monocytogenes* inoculated frozen thawed salmon. Nisin also decreased the total aerobic bacteria numbers of fresh chilled salmon (Zuckerman and Ben Avraham, 2002).

Canned food products (alcoholic beverages)

Yeast is insensitive to nisin and it can be used to control LAB spoilage in beer or wine. It can maintain its activity during fermentation without affecting the growth or fermentative performance of brewing yeast strains, and it has no negative impact on taste. As a result, it can be used to reduce pasteurization time-temperature combination and increase the duration of storage of beers (Bali *et al.,* 2012). To control bacterial spoilage, nisin may also be employed to reduce the amount of sulphur dioxide used in wine production (Todorov *et al*., 2003).

Conclusion

Bacteriocins are one of the most well-studied microbial defence systems. Foods preserved with bio-preservatives are becoming more popular as a result of increased consumer awareness and concern about synthetic chemical additives. This has led scientists to isolate new bacteriocins from food products and various fermented products such as milk products, vegetables, fruits, cereals, and meat, to name a few examples. There is a need to investigate more microorganisms that produce novel bacteriocins with unique preservation properties, bacteriocin modifications with protein engineering, construction of food grade vectors, regulation and expression of heterologous proteins, and modification and control of organoleptic properties of food items.

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