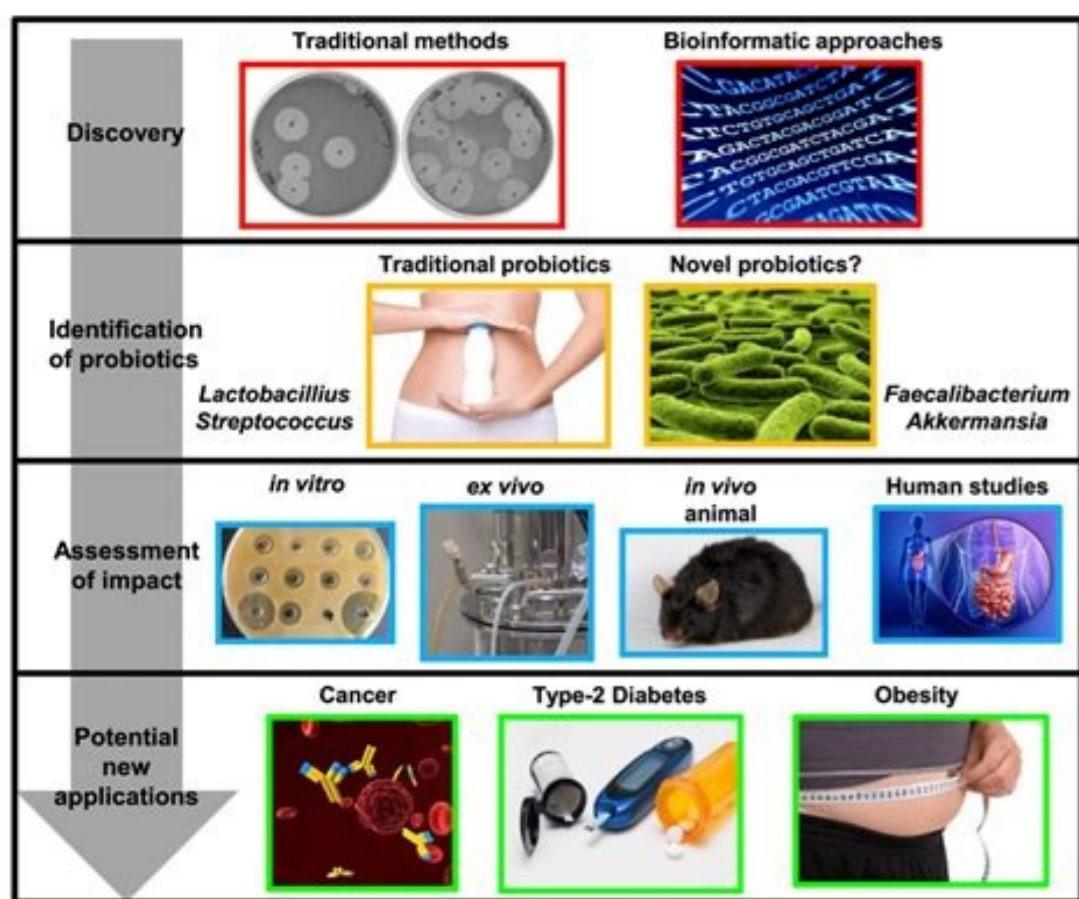


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Efficacy of Reuterin and Bacteriocins Nisin and Pediocin in the Preservation of Raw Milk from Dairy Farms

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**SUMMARY**

Research background: In the current scenario of milk production in developing and developed countries, several factors influence the shelf life of raw milk and add significant numbers of microbial contaminants that drastically lower the initial microbial quality leading to milk spoilage by the time it reaches the processing units.

Experimental approach: The present study was undertaken to investigate the biopreservative efficacy of reuterin system along with different combinations of bacteriocins in controlling the initial microflora of raw milk at farm level. *Lactobacillus reuteri* strain LR42, having effective antimicrobial activity, was shortlisted from our previous study and further characterized for reuterin production and tested in raw milk system.

Results and conclusions: Preliminary testing of the cell-free supernatant from *L. reuteri* LR42 demonstrated significant growth inhibition of the majority of the tested bacterial indicators of milk spoilage. Further genetic analysis of the *L. reuteri* LR42 revealed the presence of two genes (*nisC* and *nisA*) involved in the utilization of glucose by producing reuterin via two different pathways. The strain LR42 was also found to possess comparative ability to convert glucose into reuterin when checked through colorimetric assay. In the raw milk biopreservation experiment with reuterin alone or in combination with bacteriocins, the highest level of growth suppression in the total bacterial load and coliform counts was observed in the sample that was treated with a combination of reuterin, nisin and pediocin. The treatment combining these three natural biopreservatives at specific concentrations was able to maintain the initial microbial quality and extend the shelf life of raw milk by 6 h at 37 °C, based on the microbial counts and physicochemical properties, viz. pH and titratable acidity. In conclusion, the results confirm that the use of reuterin in combination with bacteriocins is a promising approach for temporary control of the raw milk microflora and extension of its shelf life until further processing.

Novelty and scientific contribution: This study demonstrates for the first time the use of reuterin for the extension of shelf life of raw milk as an alternative treatment method.

**Key words:** reuterin, bacteriocins, raw milk, milk biopreservation, *Lactobacillus reuteri*

**INTRODUCTION**

Milk is an important component of the diet of a vast population. It ranks high among other foods and is considered as the perfect food for humans from birth to old age. It not only has good sensory properties, but it also fulfills the nutrient requirements of the body for healthy growth. It could also prevent or reduce risk of many nutritional deficiency diseases (1). Milk, due to its unique composition and growth-promoting properties, is a favorable growth medium for many microorganisms responsible for milk-borne diseases and its spoilage (2), and for the same reason, it is highly perishable item. Proper handling of milk may affect public health and cause economic loss, thus it requires hygienic vigilance and monitoring throughout the chain (3). Milk from healthy cows is initially sterile before leaving the udder (4). Number and type of bacteria that might contaminate milk immediately after milking depend on the cleanliness and hygienic practices of the farmhands (5). Hygiene of milking equipment and dairy farm microclimate, weaknesses in the cold chain during production process, transportation, storage, etc. (6).

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Original article

**Bioactivation of PET woven fabrics using alginate biopolymer and the bacteriocin nisin**

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**Abstract**

Bioactive antibacterial PET (polyethylene terephthalate) woven fabrics were produced by fixing a thin alginate coating with entrapped nisin at the PET fiber surface. These textiles may find applications in the field of hygiene or food packaging. In the first part of the study, thin solid alginate films (without nisin) capable of forming hydrogels in aqueous medium were deposited at the PET fiber surface and the properties of the resulting textiles characterized. Methods using padding with CaCl<sub>2</sub> solution before or after sodium alginate deposition, with or without a prior PET fiber surface activation with air atmospheric plasma, were used. The following properties of the functionalized PET textile were tested: the durability and cohesion of the alginate film to the fiber surface, in water and in dry conditions under friction; the surface properties of the functionalized textile; and the water and moisture absorption capacity of the alginate films. These properties depend on the film adhesion to PET fibers and on the degree of alginate crosslinking. Entrapped bioactive nisin in the alginate film imparted antibacterial properties to the woven polyester fabric against *Staphylococcus aureus*. However, differences in inhibition zone were due to the method of alginate film formation, which had an impact on the rate of release of nisin.

**Keywords**

PET textile, alginate film, calcium chloride, adhesion, plasma treatment, nisin, antibacterial properties

Having a biofunctionalized porous textile structure is essential for diverse applications such as apparel, hygiene (for protection ex: gowns, respiratory masks), or food packaging. The use of alginate films immobilized on a textile structure would be an interesting way for producing a biofunctionalized porous structure since alginate films are able to entrap and release bioactive substances in particular conditions (1-3).

Alginate hydrogels have already been used for immobilization of proteins (such as growth factors),<sup>4</sup> and food grade alginates have been extensively used for edible coating. Moreover alginate in the form of fibers is used for wound dressing.<sup>5</sup> Alginate is a natural polysaccharide containing various proportions of manuronate and guluronate monomers which are linked by glycosidic bonds (Figure 1(a)). Guluronate monomers in one alginate molecule can be linked to a similar region in another alginate molecule by means of

calcium ions to form a gel.<sup>6</sup> Drugs or antimicrobials can thus be immobilized in alginate gels and released under certain conditions.<sup>1-3</sup>

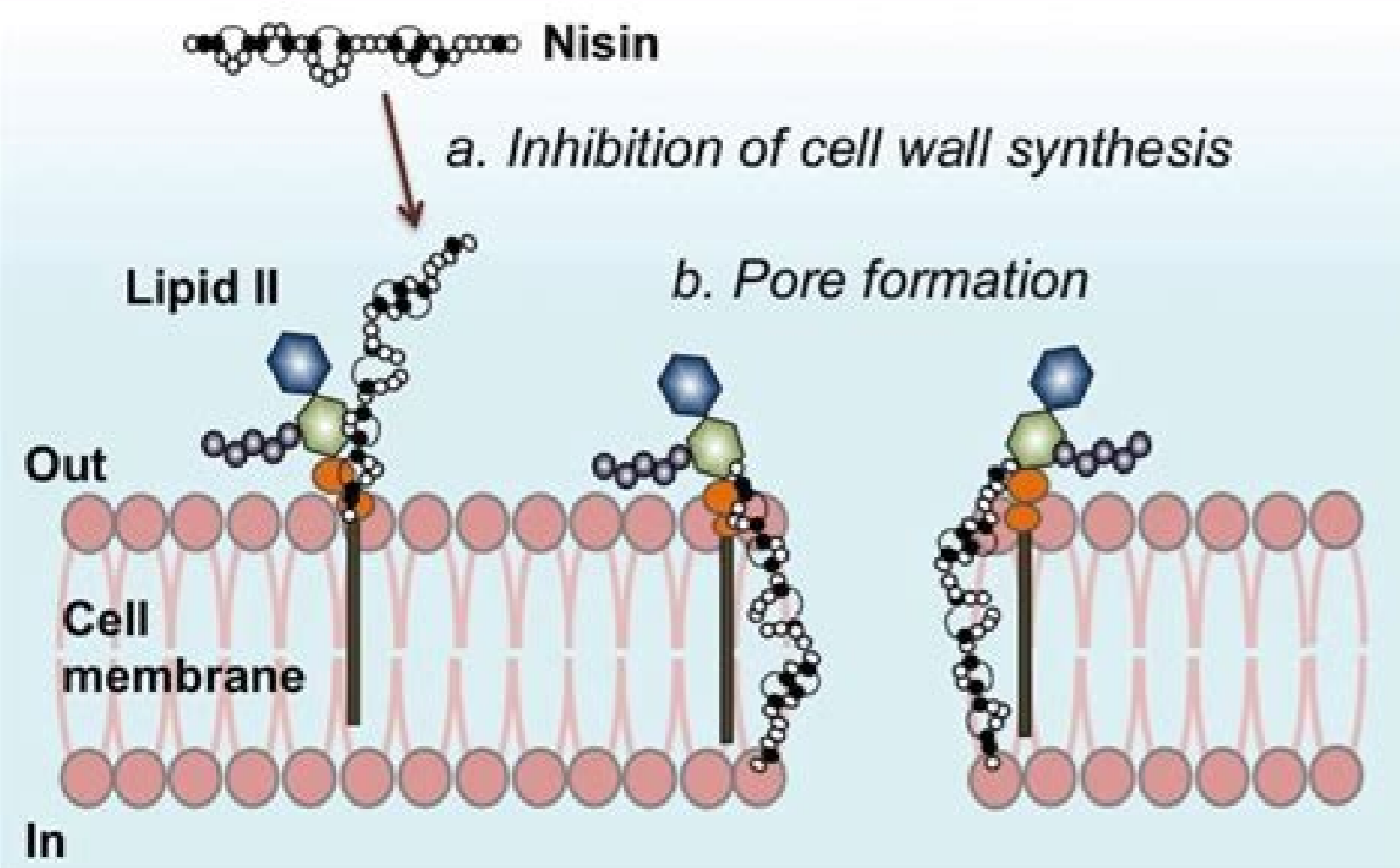
Nisin (Figure 1(b)) is a bioactive antibacterial agent already used for edible food coatings such as alginate films.<sup>7</sup> Nisin is an antimicrobial peptide produced by strains of *Lactococcus lactis* subsp. *Lactis*, and used as a biopreservative and a potential agent in

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