

Preservation of Milk and Dairy Products by Using Biopreservatives

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ABSTRACT

Dairy products help to meet the need of essential nutrients that are difficult to obtain in daily life without milk and its products like yogurt, cheese, butter. Milk is almost sterile when secreted from a healthy udder. Lower temperature and boiling the milk help in retarding the growth of spoilage organisms. Biopreservation is a method in which natural microbiota or antimicrobials are used in food to enhance the shelf-life. For this purpose affordable microorganisms are selected to control the pathogenic activity. The main organism which is used is lactic acid bacteria and their metabolites. They have the ability to show the antimicrobial features and maintain the sole flavor of food. Lactic acid bacteria are considered as great biopreservatives. Other LAB such as nisin has broad range of application in food industry and approved by food and drug administration (FDA). Other metabolites such as enterococci, Bacteriophages and endolysins used as bio-preservation and have promising role in milk storage. As these are economically important due to their drastic advantages like non-toxic, availability, non-immunogenic and broad activity so, they are considered to be good agent for biopreservation. This review will focus on application of biopreservatives to reduce the spoilage and increase the safety of milk products.

Keywords: Bacteriocins, Lactic Acid Bacteria (LAB), Enterococci, Milk, Cheese, Cream.

INTRODUCTION

Some compounds having medical properties like spices, for example, black pepper, coriander, cassia bark, cinnamon, cumin, and cardamom. In the earliest time, the human has used spices for a valuable purpose. A hundred varieties of spices were used to create the preserved food. In different industries, some spices are used for the wide applications which are beneficial for living organisms such as the type of spices are good for digestion and metabolism similar to cinnamon and ginger. Hence, material are using for production of perfumes, a color of food, and its flavor. Turmeric, ginger, red chili, garlic and small cardamom are antimicrobial effects, not all types of spices & herbs are safe for us. [22]

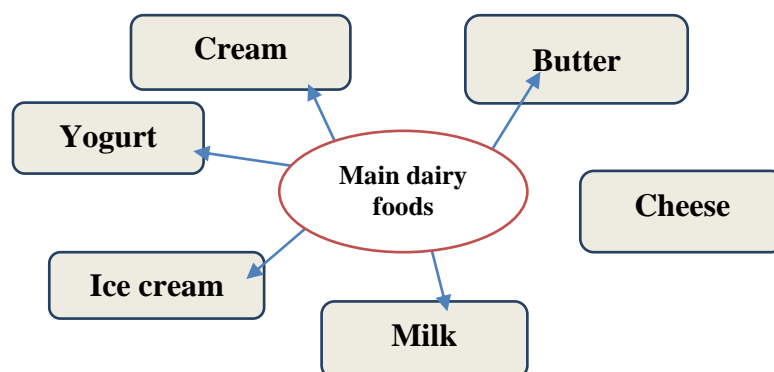


Figure 1

Bacteria are unsurprisingly occurring in the sealed food items and fermented dairy food. Bacteria held with dairy fermentation can grow over a wide temp interval from 4 to 50c. Mesophilic bacteria approximately have a growth assortment from 25-35c another side, thermophilic variety contain range 37-45c. (Johnson Steele, 2013). Such types of parameters like temperature, pH, and as well as water activity growth of bacterial cells start within dairy items including the above parameters. In the fermentation process, lactic-acid bacteria are the most important

starter culture. Lactic acid bacteria cooperate an important role and used to control the pH of dairy objects & foodstuffs & glycolysis process in milk. Another important role of lactic Bacillus is augmentation flavor in dairy products. [21]

Such types of dairy foods (include cheese & sour cream & yogurt) are formed through lactic acid bacteria fermentation process. Such type of starter culture was used in the dairy industry which has the following of this lactococcus lactic sp, L. lactic sp, and Lactobacillus Helveticas. Probiotics help to increase & addition the nutritional value of milk and its dairy material. Some lactic acid bacteria have same nature as Probiotics. In the food material, using are Probiotics strains & gram positive Lactobacillus sp & Bifidobacterium. In review paper, we discuss live bacteria that occur in the gut & are vital for Probiotics that's why due to its quantifying and envision the colonies of bacteria in food items.[22]

In the field of food processing, different species have been utilized for the purpose of preservation milk and dairy products in different countries through various methodologies for preserved food & milk. There are use Probiotics for humanizing the dietary value of food and enhance the flavor and health. Prebiotics are also used for the superior performance of Probiotics. [1]

Basically, Probiotics are living microorganisms include yeast & bacteria which is preferred to use in food due to increasing the shelf life of food and better quality of food. A few important Probiotics are used for the management of health issues such as food allergic reaction & colon cancer, etc. protein powder, eggs, fruits, yogurt, avocado, cooked quinoa, olive oil, seeds, and nuts are most essential Probiotic foods.

Commonly, food industries were using the chemicals for food saving processing. Chemicals were used to increase the shelf life of food material for later use. Chemicals are manufactured hazardous effects on the human physical condition and effect on the dietary significance of foodstuff. Nitrates & sulfur dioxide such type of chemical were used. The term antimicrobial peptide was explained that how to food preserved without any altering of dietary value and quality of food and its aroma. Chemicals are unhealthy for a consumer that's why we prefer the best naturally occurring preservation method held to recognize. Hence, there is necessary or significant require to establish the best methodology and other way to preserve the foodstuff. The food item can be preserved by microbes & microorganisms & bacteria to strengthening the shelf life of food. Some technique is using nowadays for the preservation of dairy products like peptide synthesis, chemical synthesis, enzymatic synthesis, and recombinant synthesis.[2]

The overweight population has been beloved to reduce their weight through do exercises and diet planning, there are big population who has most wanted to weight loss through in well and sustainable way & that's why dairy products help them to control their overweight by checking and balanced way their weight. The obese person wants to become healthy through different types of exercise and diet roles. The micro-nutrients and macro-nutrients occur in the preserved food and dairy fermented foodstuff. The most advantageous dietary nutrient composition to achieve weight reduces remains a controversy. The nutrition is allowing to patients, the take proteins lower carbohydrates, lipid in their diets for a healthy lifestyle.

When overweight people eating higher proteins than they should go for exercise & workout. While those one who intakes higher proteins for weight maintainer are the concern and other one intake higher proteins in that case compared who intake low proteins. Higher proteins with a combination of hard work are better than take lower calories with no workout. Humans have linked the consumption of dairy food materials and calcium gain from dietary food to faster weight reduction and loss's fat molecules from the body. In this study, we expected to get the weight loss with a high value of fats and introduced the prototype which is sufficient for the long term metabolic & and short term metabolic activities that are obligatory for body figure maintain. In one program, we should collect the steps that should follow such as the energy limit, protein with low carbohydrates, highly nutritional value & increase the dose of dietary fibers and aerobic exercise.

Nowadays, we are facing the major problems that are food losses in the worldwide level, and one-third part around destroys from the human consumption food, such products include dairy items, fish, vegetables, seafood, meat, and some other cereal crops are wasted in huge amount. Fungi and some type microorganisms or the main reason of disturbing the food chain because they have the ability to grow in every environment, fungal infection have ability produced to the toxic effect on human health, animals and plants. Fungi be heterotopy and food absorbing microorganisms from moist areas and either they produce from the sexual or asexual process, they can move easily from one to another place by spores and wind and rapidly mature and start lifecycle again and again and cause the infection. These foods are tested by thermal treatment such as sterilization, pasteurization, & water removal by drying & freezing-drying & high titer of high sugar or salt [3]. The major issue of loss disease free years in Nordic countries today is diseases like type 2 diabetes, cardiovascular diseases, and cancers. Moreover, the increasing occurrence of obesity greatly increases the risk of these chronic diseases. The increasing prevalence of different chronic diseases, it is most important to understand the health effect of milk and dairy products in the diet. In earlier times, milk was used for a longer time due to its vast process of preservation as it was completed in three steps: Pasteurization, Sterilization, Dehydration.

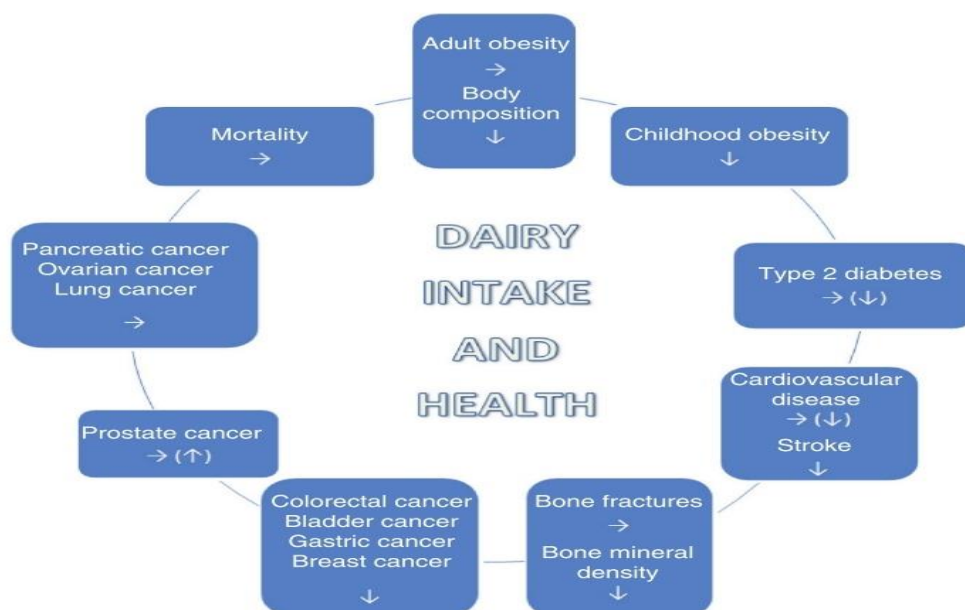


Figure 2: Overall association between dairy product intake and health outcomes

These processes convert raw milk into other forms of dairy products for the consumption of mankind. This method was adopted on a small scale level and other level for milk processing. The main purpose for the preservation is that to control the growth of spoilage microorganisms that cause contamination in storage and to increase the shelf-life of products. [4]

Favorable involvement conditions

Two types of bacteria can grow on milk and its products: Spoilage bacteria, Pathogenic bacteria.

Spoilage bacteria cause unpleasant flavor, odor, and taste while pathogenic bacteria not show these symptoms and cause illness.

The main principles of preservation are to control microorganisms by killing them and their spores, by control their enzymes and control all physical sources that provide deterioration in milk.

Table 1

Raw side	Processing	Packaging and distribution
Receiving	Pasteurization	By filling machines
Storage	Sterilization	Delivered to market
	Dehydration	Homes and refrigerator

As this process is time-consuming and laborious so chemicals also added to preserve milk products, for example, acids organic & inorganic acids, antimicrobial agents, antioxidants, and other compounds like these are added. Due to their adverse effect on human health restricted the use of chemical method.[5]

Methods for preservation of milk and dairy products

Biopreservatives play an important role due to their advantageous effects on health as compared to chemical preservatives. Different types of microorganisms are classified and studied by researchers to estimate beneficial uses for preservation.[6], [7]

The role of lactic acid bacteria in preservation

Lactic acid bacteria (LAB) LAB is generally included Lactococcus, Streptococcus, Lactobacillus, Pediococcus, Leuconostoc, Enterococcus, Carnobacterium, Aerococcus, Oenococcus, Tetragenococcus, and Vagococcus. All these micro-organisms are Gram-positive, nonmotile, non-spore forming, rod- and coccus-shaped organisms and are able for fermentation of carbohydrates. The main product obtained as a result of fermentation is lactic acid. The composition of the LAB contains fewer proportions of G+C contents in their DNA. The basic function of Lactic Acid Bacteria in food fermentation and processing is like GRAS (generally recognized safe). The LAB can be used for the production of different fermented products of dairy Major compounds produced by LAB for fermentation are organic acids, hydrogen peroxide, and bacteriocins. Additionally, Lactic Acid Bacteria can be used for the production of probiotics. The application of antimicrobial producing lactic acid bacteria (LAB)[8] for the manufacture of dairy products, which can be used into fermented or non fermented milk and dairy products, help for a processing advantage to improve safety and increase the quality of dairy products, providing an additional

hurdle to less the likelihood of food-borne diseases. These peptides are considered natural biopreservatives and their potential application in the food industry provides great interest. [15] as biopreservative: Bacteriocins defined as peptides that are synthesized from bacteria that slow down & destroy other related or unrelated microorganisms to save the Food. Bacteriocins are classified into 3 major classes on the base of their biosynthetic action and activity.

Class-1 tiny post-translationally customized peptides

Class-2 unmodified bacteriocins⁹

Class-3 large peptides

Bacteriocins have been used as biopreservative by different methods either alone or combine with other methods like in hurdle technique. The recent application of bacteriocins into dairy food to control the pathogens includes the food with lactic acid bacteria that cause to produce bacteriocins. Mostly dairy products which made from pasteurized milk, conserved at refrigerator temperature allow the enlargement of bacteria such as *L. monocytogenes*. So infectivity can happen in later stages of processing of dairy products. Bacteriocins are also used for other purposes like food fermentation, improve flavors and cheese ripening.[9] These also help to improve the safety of dairy products by using different Strains combinations of different preservation methods that provide high protection than the single strain. These bacteriocins helpful for the prevention and reduction of intestinal pathogens produce probiotics that have the ability to survive in GIT may be advantageous. [18]

There are some types of bacteriocin that are used for the prevention of milk-borne pathogens like

Nisin

The bacteriocin nisin can be classified as lantibiotic and the most utilized and commercially available bacteriocins. These are approved as a food preservative and are recognized the safest by the World Health Organization (WHO) Experts Committee on Food preservatives. Nisin has an antimicrobial activity which is next to for Gram-positive bacteria as well as Lactic Acid Bacteria, pathogens like *Listeria* and *Staphylococcus*, and the spore-forming bacteria, *Bacillus*, and others. One of the most important applications of nisin was to prevent the late blowing in dairy product cheese caused due to gas-producing *Clostridium* spp. It has been of great interest to use new bacteriocins with a wide range of antibacterial activity, stable in different food varieties, tolerable to high temperature and resistant to proteolytic enzymes.[2]

Pediocin

These classified as II. Bacteriocins and commercially available for the preservation of dairy products these bacteriocins are more effective than other classes. They are stable in aqueous solutions, pH resistant and have little impact on freezing and boiling[10].

Lacticins

lacticins are formed from convinced strains of *Lc. Laticis* and consist of lacticins 3147 and lactic in 481. A lacticins 3147 powder preparation was effective for control of *Listeria* and *Bacillus* in infant milk formulation, natural

yogurt, cottage cheese, and other dairy products. However, the application of lactic in food not likes to ensure the complete eradication of pathogens such as *L. monocytogenes* and others.[8], [11]

Enterocins

Enterocins are strains that evolve from enterococci and are safe to use in food applications, but these are associated with infectious microorganisms in humans and other living organisms. To use enterococci for food purposes their purified form is available and suitable for food intake. They become active against foodborne pathogens and help to prevent the growth of other microorganisms.[17]

The elevated cost of bacteriocin separation and distillation also confines the commercial discovery of new bacteriocins. In adding, the restrictive food legislation of the physical condition regulatory authorities limit the support of new bacteriocins as food preservatives and, as a consequence, only two bacteriocins (nisin and pediocin) are commercially accessible[12]

Utility of enterococci to preserve dairy products

Enterococci were described for the first time from scientist Thiercelin in 1899 and genus *Enterococcus* was proposed by Thiercelin and Jouhaud in 1903. Presence of enterococci in milk and dairy products are beneficial by contributing to produce unique and emerging by-products, by protecting against diverse spoilers, and as probiotics. Due to their adverse nature, heat resistance and adaptation to the different substrate and environmental conditions, they can grow during freezing and survive after the pasteurization of milk and its products. So, enterococci are a part of raw and pasteurized milk. More importantly, in cheeses, such as Mozzarella, Cheddar, enterococci are the major microorganisms in the completely ripened product High levels of contaminating enterococci could produce to deterioration of sensory products in some cheeses but they also play the important role in cheese ripening and aroma development. Safe and commercially available strains of enterococci are use in food and as probiotics and they should possess neither any virulence factors, nor should be able to obtain an antibiotic resistance gene. [16]

BACTERIOPHAGE AS BIOPRESERVATIVE

Bacteriophages or phages are the most widely found microorganisms on planet earth and widespread on foods of different origins. These are viruses that specialize to infect and multiply in bacteria and are harmless due to host specific to humans and other living organisms. In bio-preservation, bacteriophages can work as symbiotic an association with fermenting organisms during fermentation. It is a very effective method for the preparation of food processing and reduces effectively the like Salmonella in cheddar production Endolysins. Endolysins are called as phage lysins which are referred to as phage-encoded peptidoglycan hydrolases and employed from majority of bacteriophages to enzymatically degrade the peptidoglycan layer of the host bacterium. Bacteriophages are also utilizing the endolysins at each end of their replication cycle for degradation, of the peptidoglycan of the bacterial host. Endolysins are good antimicrobials due to the absence of an outer membrane covering in the Gram-positive bacterial cell wall. In bio-preservation, bacteriophages work symbiotically with fermentative microorganisms during fermentation. It is the most effective method to prepare food processing and fewer effects like Salmonella in cheddar cheese, *S. aureus* growth in curd manufacturing and complete eradication of *Listeria monocytogenes*

during ripened formation and storage of acid coagulation and semi-hard cheeses. It was also inhibition of *Enterobacter sakazakii* for reconstituted infant formula milk. [14]

Endolysins

Endolysins are also good antimicrobial agents due to the absence of an outer membrane in the Gram-positive bacterial cell wall. It is easily accessible to peptidoglycan. Endolysins usually have narrow spectrum lytic activity and less restricted to phage host bacterial activity. The role of endolysins in milk bio-preservation is still in seniority. But there are many endolysins are isolated that work against different foodborne pathogens. The good thing in this regard is that no-existence of resistance against endolysins now date. It is suggested by several researchers now that transgenic cows expressing more endolysins that have low chances of mastitis and *S. aureus* milk contamination. Endolysins are also having a role in dairy processing, particularly in endolysins to destroy *S. aureus* in pasteurized milk. [14]

CONCLUDING REMARKS

Major, aim of dairy trade is to produce dairy foodstuffs with more nutrition and fitness enhancing property. This review explains all the aspects related to the recent trends for using bacteriocins producing bacteria and bacteriocins in dairy products. Pasteurization and refrigeration are important to control pathogens but restricted due to the presence of species that survive after this process so it is also the need of time to discover novel bacteriocins that having unique properties for application in dairy foods. Concentrated culture of bacteriocin is more efficient as compared with the direct addition of cultures. The starter culture should be able to produce bioactive metabolites. The foremost imperfection linked with this function that the lack of compatibility of strains and other cultures for the fermentation of dairy products. But biopreservative have a promising role in food preservation and safety. Genetically modified Bacteriophages helpful for preservation, but their safety should be proper for selected as biopreservative agent. Some lactic acid bacteria are of great importance in traditional cheese formation from raw milk. The use of lactic acid bacteria is functional starter culture in dairy products like in yogurt and ice-cream. These lactic acid bacteria have positive effect like anti obesity and anti diabetes. Bacteriocins, enterococci, Bacteriophages, endolysins, LAB these all biopreservative have major role and applications in improving food safety.

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