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LACTIC ACID BACTERIA AND THEIR BENEFICIAL EFFECTS IN FERMENTED DAIRY PRODUCTS

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ABSTRACT

The main focus of this review is the investigation of the roles of lactic acid bacteria (LAB) in fermented food prepared from dairy sources. LAB has been used extensively in food fermentation across the globe as potential microorganisms. Around the world, several species of LAB are employed as starter cultures in several fermented dairy products. Fermentation of milk and milk products involves the LAB genera *Lactobacillus*, *Streptococcus*, *Leuconostoc*, *Pediococcus*, and *Lactococcus*. LAB can be widely employed in developing novel fermented milk products, given the existing knowledge of its numerous health-promoting properties. LAB is widely known as a natural approach to the fermentation of food and enhancing a healthy life. In recent years, there has been a surge of interest in researching LAB to know more about their effects on starter culture or probiotic activity. From a microbiological viewpoint, the diversity of LAB involved in different fermented dairy products are extensive. LAB identified in fermented products could be assessed for their potential beneficial properties to enhance the quality of the product produced. So, the study's goals are to learn about the most recent studies on LAB, which is found in fermented dairy products, as well as their characteristics and health benefits.

Keywords: lactic acid bacteria, fermented dairy products, starter culture

INTRODUCTION

Lactic acid bacteria (LAB) species are grouped into several genera under the Lactobacillaceae family. They are always an integral part of fermented dairy products and are widely utilized in the fermented food industry (Wang *et al*., 2021). LAB ferments milk's lactic acid and acts as a probiotic, improving gut microbial balance (Bin Masalam *et al*., 2018) and benefiting host health (Li *et al*., 2020).

Dairy products are considered primary dietary sources of LAB, which can be found naturally or added afterwards (Reuben *et al*., 2020). Although lactic acid bacteria include more than 60 genera, the most frequent genera in food fermentation generally include *Lactobacillus, Lactococcus, Leuconostoc, Pediococcus, Streptococcus, Enterococcus, Weissella,* (Mokoena, 2017., Li *et al*., 2020). *Lactobacilli* such as *Lactobacillus acidophilus*, *L. casei*, *L. paracasei*, *L. rhamnosus*, *L. delbrueckii* subsp. *bulgaricus*, *L. brevis*, *L. johnsonii*, *L. plantarum* and *L. fermentum* are commonly used as probiotic products (Nawaz *et al*., 2011, Panesar, 2011).

Exopolysaccharides produced by LAB are used in the food industry as emulsifiers, stabilizers, thickeners, gelling agents, and to keep in moisture, change rheology, firmness, and syneresis, and improve texture, mouthfeel, and sensory properties (Korcz and Varga, 2021). Many studies have shown that lactic acid bacteria may produce antioxidant metabolites. Antioxidant compounds produced by LAB in fermented foods are quite safe and may have several positive impacts on human health (Feng and Wang, 2020).

Scientists reveal LAB's health advantages. The health advantages include anti-allergic, anti-carcinogenic, prevention of gastrointestinal infection, constipation relief, immune system activation, and cholesterol-reducing (Panesar, 2011). In many aspects related to LAB functions, preservation and milk fermentation are explained in different research articles. The main target of this review paper is to provide the reader with summarized data related to the beneficial effect of LAB in fermented dairy products, its features and health benefits.

Different fermented dairy products

LAB is essential in the fermentation of milk, the process by which raw milk is transformed into

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fermented milk products. Various LAB strains have been discovered, and their distinctive traits and actions have been used in the industrial production of fermented milk products. LAB's proteolytic activities change milk protein, resulting in acidification and the addition of taste and texture. Yogurt and cheese are two examples of fermented milk products, and both of them have a pleasant, mild acid taste and a delightfully firm texture (Widyastuti *et al*., 2014). Almost all domestic milch animals' milk (usually cow milk, buffalo milk, ewe milk, goat milk etc.) can be used to make fermented dairy products. Several unique fermented milk products are gaining rapid growth in popularity in many parts of the world. Milk fermentation involving LAB could occur naturally or be artificially induced. Several of these microorganisms are capable of colonizing new environments and transforming milk into an array of healthy fermented dairy products (yogurt, cheese, kefir, fermented milk, lassi, borhani, kumys etc.) (Garcia-Burgos *et al*., 2020). Consumers' increasing demand for therapeutic goods has resulted in the widespread use of probiotic microorganisms in dairy products. Members of the bacterial genus *Lactobacillus* or *Bifidobacterium* are the most common types of probiotic bacteria found in today's commercial products (Panesar, 2011).Microorganisms used in fermented foods and beverages include bacteria (e.g. *Lactobacillus*, *Streptococcus*, *Enterococcus*, *Lactococcus* and *Bifidobacterium*), moulds (e.g. *Aspergillus oryzae*, *Aspergillus sojae*, *Penicillium roqueforti* and *Penicillium chrysogenum*), and yeasts (e.g. *Saccharomyces cerevisiae*, *Candida krusei* and *Candida humilis*) (Xiang *et al*., 2019). They may be thoroughly investigated in the creation of novel fermented milk products since they are widely accepted as safe and possess a variety of health-promoting properties. Different popular fermented dairy products and LAB used in the preparation of these products will be discussed here.

Fermented milk

Fermented milk is a type of dairy product made by lowering the p^H of milk by the activity of appropriate microorganisms, with or without coagulation, in accordance with the legal restrictions (isoelectric precipitation). These inoculating microorganisms must remain alive and intact in the product over its minimum shelf life. There is a unique culture utilized in the fermentation of each type of fermented milk (Garcia-Burgos *et al*., 2020).

Fermented milk products or cultured dairy products that have been fermented by a group of lactic acid bacteria cause milk curdling or sourness and also help milk retain its flavour and nutritional value (Mokoena, 2017). Starter cultures for fermented milk serve many purposes, including improving the sensory, textural properties, and nutritional qualities of the final product by increasing the production of bio-preservative compounds that preserve the milk and ensure it is safe to consume. Active starter cultures require strict adherence to standards of cleanliness and long-term viability if they are to serve their intended purpose (Surono and Hosono, 2011). *Lactobacilli* can grow from 1 to 10 million cells per millilitre by metabolizing and growing somewhat on milk's nutrients. During fermentation and storage, the microorganisms produce primary and secondary metabolites and enzymes, which are present in the fermented milk both as living cells and as autolyzed cells. Therefore, fermented milk's nutritional value is determined by the nutrient contents present, the ease with which they can be digested, and the alterations to these components that occur during the microbial growth and fermentation processes. (Xiang *et al*., 2019). The production of fermented milk relies heavily on mesophilic cultures. Use of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* as a thermophilic starter culture, and *Lactococcus lactis* subsp. *cremoris* and *Leuconostoc* sp. as a mesophilic starter cultures, both are common and used for the fermentation of fermented drinks (Surono and Hosono, 2011). Different types of fermented milk are gaining popularity due to their numerous beneficial effects on human health.

Cheese

Cheese is made by a process of microbial fermentation in which certain lactic acid bacteria (LAB) convert lactose into lactic acid. This lowers the curd's pH to a particular degree (Hayaloglu, 2016). Various strains of lactic acid bacteria are widely used in the production of a wide variety of cheeses. LAB starter cultures may either be mesophilic from the genera *Lactococcus* and *Leuconostoc* or thermophilic from the genera *Streptococcus* and *Lactobacillus*. *Streptococcus thermophilus*, *Lactococcus lactis*, and *Lactobacillus helveticus* are the three species that have undergone the most thorough research. *L. helveticus* plays a substantial part in the production of certain taste compounds in Italian artisan cheeses. (Widyastuti *et al*., 2014) Protein catalysts produced by the microorganisms degrade complex compounds, such as the proteins and sugars in milk, into simpler molecules that can often be kept for longer periods than the original material via a process called microbial fermentation. Cheese made from fermented milk may be eaten months or even years after the milk itself would have gone bad. Cheeses that have been matured for 12 months or more have a more robust taste, aroma, and texture than their fresh counterparts, which may be served immediately after production. (Swanson *et al*., 2014) Mesophilic lactobacilli such as *Pediococcus* spp., *Enterococcus* spp., and *Leuconostoc* spp. are the most frequent non-starter lactic acid bacteria (NSLAB) in white-brined cheeses. However, white-brined cheeses had negligible levels of *pediococci* and *enterococci*. A study found that the addition of *Enterococcus durans* and *E. faecium* enhanced the cheese's flavour and texture. NSLAB are present in all cheeses, even unripened cheeses, but only after they have been aged for some period of time (Hayaloglu, 2016). Mesophilic starters consisting of *L. lactis* subsp. *cremoris* and *L. lactis* subsp. *lactis* are employed as starters in the production of cheddar cheese, while the other strains of *lactobacilli* may be added just to aid in taste formation and hasten the cheese's ripening process (e.g., by using *L. helveticus*, *L. casei*). It has been suggested that *S. thermophilus* may be utilized for rapid acidification (Hayaloglu, 2016). Therefore, there is a use of different starter LAB and NSLAB in the production of various soft, semi-hard and hard types of cheese.

Dahi/ Yogurt

Dahi is the oldest and most widely consumed fermented milk product. Dahi can be eaten plain or with the addition of salt or sugar. Usually, dahi is prepared using a simple art or technology following the traditions. It is either prepared in consumers' homes or in urban sweet maker businesses. The milk is heated in the home, then cooled to room temperature, and then added with a tablespoon of starter culture (previous day's dahi or buttermilk) (about 0.5-2.0 %) and allowed to set overnight (Shah, 2017). It is preferable to apply well-known starter mixtures for producing dahi on a big scale with known, uniform quality. *Lactococcus lactis* ssp. *lactis*, *L. lactis* ssp. *cremoris*, *L. lactis* ssp. *diacetylactis*, *Leuconostoc* spp., *Lactobacillus* spp., and *Streptococcus thermophilus* are the most used starter microorganisms in the preparation of dahi (Shah, 2017). Because of their greater acid tolerance, *lactobacilli* predominate in sour dahi and *streptococci* predominate in sweet dahi (Shah, 2017). Lactobacillus (62%) was the predominant bacterial species in the dahi sample, followed by Streptococcus (38%) (Nahidul-Islam *et al*., 2018). The starter cultures, processing conditions, milk supply, chemicals and additives used to make yogurt all contribute to its final flavour. The starting cultures used in the fermentation process are a particularly important contributor to the development of taste components. Several countries only allow goods to be labelled "yogurt" if they are made with starters containing strains of both *S. thermophilus* and *Lb. delbrueckii* subsp. *bulgaricus*, the two bacteria that make up the conventional yogurt culture (Shah, 2017). Flavour compound production was evaluated by Beshkova *et al*., (2012) during lactic acid fermentation using a mixed culture and they found that the highest concentration of flavour compounds occurred between 22 and 31 hours into the cooling stage. Yogurt often contains commercial probiotic microorganisms from the families *Lactobacillus* and *Bifidobacterium*. (Nyanzi *et al*., 2021). Yogurt, Bulgarian buttermilk, and the whole spectrum of goods prepared with gut bacteria, principally *lactobacilli* and *bifidobacteria*, all employ thermophilic starting cultures. Yogurt of varying flavours relies on thermophilic starter cultures. They are added to yogurt for their purported health advantages, but they also change the flavour. When making stirred yogurt, mesophilic microorganisms are utilized (Surono and Hosono, 2011). Therefore, yogurt is very popular in many parts of the world as a dessert after heavy meals due to its efficiency in digesting foods and other beneficial health properties.

Borhani

Borhani is a yogurt-based drink that is often offered during lavish gatherings like weddings and celebrations. Pepper, mint leaves, cumin seeds, green chillies, sugar, salt, and water are all added before being blended till smooth. After that, it's chilled by being stored in a fridge (Hossain and Kabir, 2016). Sour yogurt is an essential ingredient in making borhani. It's a great nutritional choice since it has a wide variety of nutrients including protein, carbohydrates, fats, vitamins, and minerals (Bari *et al*., 2020). *Lactobacillus* (43%), *Streptococcus* (20%), and *Pseudomonas* (3%), in addition to the most frequent LABs, was discovered as predominant bacteria in borhani (Nahidul-Islam *et al*., 2018). Whole milk curd borhani had the most nutrient value and were the most popular with consumers, however, preparing borhani using skim milk curd or full cream powder milk curd was more cost-effective. It can be established, however, that borhani made with whole milk curd is superior to other forms of borhani in terms of both nutritional content and customer preference (Bari *et al*., 2020). As borhani is made from dahi blended with mint leaves, it has an effect on digestion.

Kefir

Kefir is a fermented milk drink similar to a thin yogurt which is prepared through the symbiotic fermentation of milk by lactic acid bacteria and yeasts contained within an exopolysaccharide and protein complex called a kefir grain (Garrote *et al*., 2001). Kefir grains were first described by the tribes in the Northern Caucasian mountain region of Russia (Seydim, 2001). Kefir grains are generally symbiotic colonies of bacteria and yeast in a protein and lipid matrix. Kefir differs from other fermented products because of the particular characteristic of its starter culture special flavour and taste. LAB is the main population in kefir grains accompanied by acetic acid bacteria and yeasts (Dong *et al*. 2018). Lactic acid bacteria generally produced lactic acid, acetic acid and antimicrobial compounds that help the preservation of the kefir (John and Deeseenthum, 2015) and also organoleptic properties by producing volatile compounds (e.g. acetaldehyde), exopolysaccharides (Rimada and Abraham, 2003) or free amino acids (Guzel-Seydim *et al*., 2011). Alcohol and carbon dioxide are produced by yeasts produced in the milk that contribute to the mouthfeel and taste of kefir (Rosa *et al*. 2017).

The bacterial genera most commonly found in kefir using culture-dependent techniques are *Lactobacillus*, *Lactococcus*, *Streptococcus*, and *Leuconostoc.* Among them, *Lactobacillus acidophilus* is one of the predominant species. (Simova *et al*., 2002; Witthuhn *et al*., 2004; Chen *et al*., 2008). There were anywhere between 65% and 80% *Lactobacillus* and *Lactococcus* in kefir grains, with yeasts making up the rest of the microbial makeup. 80 percent of the *Lactobacillus* were identified as *Lactobacillus kefir*, while the remaining 20 percent were identified as one of the following: *Lactobacillus acidophilus*, *Lactobacillus paracasei* subsp. *paracasei*, *Lactobacillus delbrueckii* subsp. *bulgaricus*, *Lactobacillus plantarum*, or *Lactobacillus kefiranofaciens* (Rosa *et al*., 2017).

Scientists are interested in kefir because of its claimed health benefits, which include better digestion and lactose tolerance, antibacterial effect, hypocholesterolemic effect, control of plasma glucose, anti-hypertensive effect, anti-inflammatory effect, antioxidant activity, anti-carcinogenic activity, and anti-allergenic activity.

Role of LAB as a starter culture in fermented dairy products

A "starter culture" is a microbial preparation comprising significant populations of cells of at least one microbe added to raw material to generate a fermented food, which enhances and facilitates the fermentation process. There is a long and safe history of using LAB in the manufacturing of fermented dairy foods and beverages, thus they are an integral part of these processes (Hati *et al*., 2013). In a wide variety of processes involving the fermentation of milk and the storage of food, LAB is indispensable, and the importance of their contributions cannot be overstated. LAB have been used to improve product features and impart particular properties that promote customer satisfaction and interest. As a result, several traditional dairy products have been made utilizing lactic acid bacteria. The majority of the goods that are created via the utilization of LAB also provide greater health benefits to the customers, which is essential for the maintenance of a healthy digestive system (Ayivi *et al*., 2020). The flavour and aroma of fermented items can be enhanced by the presence of LAB. They cause the food to become acidic, giving it a flavour similar to that of lactic acid, frequently engage in actions that are proteolytic and lipolytic, and create aromatic substances. As a result of their excellent synthesizing capacity and the ability to create aromatic compounds, wild strain starters and NSLAB play a crucial part in the process of flavour formation. Increased levels of amino acids, peptides, and liberated fatty acids are produced as a result of the incorporation of NSLAB as adjunct cultures during the production of cheese. This results in a more robust flavour profile and quicker maturation of the cheese. (Hati *et al*., 2013). LAB is responsible for the production of fermented foods as well as the development of their flavour through the processes of proteolysis, glycolysis and lipolysis. Despite the fact that the major metabolic action is the production of lactic acid from the fermentation of carbohydrates, also known as the acidification of the food, LAB are involved in the production of many bioactive components (Bintsis, 2018).

Gram-positive, non-spore-forming, catalase-negative, cytochrome-deficient, non-aerobic yet aerotolerant, fastidious, acid-tolerant, strictly fermentative bacteria called lactic acid bacteria create lactic acid as the principal end product of sugar fermentation (Konig and Frohlich, 2017). They can't make a proton gradient, which is necessary to produce ATP, since they can't make cytochromes and porphyrins (parts of respiratory chains). Fermentation of carbohydrates is the sole source of ATP for the lactics. Lactic acid bacteria thrive in anaerobic environments because they do not need oxygen for energy generation; yet, they may also expand when exposed to oxygen. Because they contain peroxidases, they are safe from oxygen radicals. The capacity to ferment hexoses to lactic acid is what sets these organisms apart from others, thus the name. Because of their differing carbohydrate fermentation capabilities, LAB is classified as either homofermentative or heterofermentative. One molecule of glucose is converted into two molecules of lactate by homofermentative LABs, such as *Lactococcus* and *Streptococcus*, whereas glucose is converted into lactate, ethanol, and carbon dioxide by heterofermentative LABs, such as *Leuconostoc*, *Wiessella*, and some *lactobacilli* (Mokoena, 2017).

Because of their restricted metabolic capabilities, lactic acid bacteria must get their carbon and energy from external sources, such as sugar. It is common practice to use a nutrient-dense media for growing lactics. Due to their stringent needs, they can only live in places where certain compounds are plentiful (animals, plants, and other multicellular organisms). Most lactic acid bacteria strains can thrive in a pH range from 4.4 to 5.5, and they can survive temperatures ranging from 5 to 45 degrees Celsius (Konig and Frohlich, 2017). LAB has extensive effects on fermented food preparation, therefore it is very popular. The health effects of LAB will be discussed later on. The species of lactic acid bacteria which were commonly used in the preparation of fermented dairy products is given in the following table 1:

Table 1. Starter cultures used in fermented dairy products

Fermented Dairy Products	Starter Cultures	References
Cultured buttermilk	*Streptococcus lactis* subsp. *diacetylactis, S. cremoris*	Ayivi *et al*., 2020
Dahi	*Lactobacillus fermentum, Lactobacillus delbrueckii subsp. bulgaricus, Streptococcus thermophilus, Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. lactis biovar diacetylactis, Leuconostoc mesenteroids subsp. mesenteroids, Streptococcus thermophilus*	Bhattarai *et al*., 2021; Bangaragiri *et al*., 2021; Rai, 2020
Hard Cheese	*Lactococcus lactis subsp. lactis, L. lactis subsp. cremoris*, *Streptococcus thermophiles*, *L. delbrueckii subsp. bulgaricus*, *Lactobacillus helveticus*	Hayaloglu, 2016; Gobbetti *et al*., 2018
Hard cheese without eyes	*Lactococcus lactis* subsp. *lactis, Lactococcus lactis* ssp. *cremoris*	Hayaloglu, 2016
Kefir	*Lactobacillus acidophilus, Lactobacillus kefir, Lactobacillus kefiranofaciens*	Chen *et al*., 2008; Rosa *et al*., 2017
Kumiss	*L. acidophilus, L. bulgaricus, L. casei*	Ghosh *et al*., 2019; Panesar, 2011
Lassi	*Lactococcus lactis ssp. cremoris, Lactobacillus casei*	Adiver *et al*., 2021
Leben	*S. lactis, S. thermophilus, L. bulgaricus*	Panesar, 2011
Shrikhand	*Lactobacillus bulgaricus, Streptococcus thermophilus*	Sahu, 2021
Surface mould cheese	*Lactococcus lactis subsp. lactis and L. lactis subsp. cremoris*	Panesar, 2011; Hayaloglu, 2016
Swiss cheese	*Lactobacillus delbrueckii* ssp. *lactis, Lb. helveticus, Streptococcus thermophiles*	(Hayaloglu, 2016)
Tofu	*Lactobacillus plantarum*	(Li *et al*., 2020)
Yogurt	*Lactococcus lactis* ssp. *lactis, L. lactis* ssp. *cremoris, L. lactis* ssp. *diacetylactis, Leuconostoc* spp., *Lactobacillus* spp., *Streptococcus thermophiles, Lactobacillus delbrueckii* subsp. *bulgaricus*	(Shah, 2017; Chen *et al* 2017; Laino *et al*., 2013)

Health benefits of LAB

Some studies have shown that using LAB to make fermented dairy products has positive health effects. *Lactobacillus acidophilus* with dairy products may reduce blood cholesterol, alleviate lactose intolerance, and reduce colon cancer risk (Zhang *et al*., 2019). Acidification of the starting materials is triggered rapidly by LAB due to the production of organic substances, most notably lactic acid. In addition to acetic acid and ethanol, other by-products include aroma compounds, bacteriocins, exopolysaccharides, and many enzymes (Hati *et al*., 2013). LAB is used for its different beneficial effects such as bacteriocin production, antiviral activity, anti-diabetic activity, anti-allergic, anti-obesity anti-diarrheal activity, prevention of lactose intolerance and so on (Ayivi *et al*., 2020). Several studies have shown that consuming fermented milk products improves human health. There are several ways in which LAB may be utilized as a probiotic to help keep us healthy. The starting culture of *S. thermophilus* and *L. delbrueckii* subsp. *bulgaricus* utilized in Koumiss has anti-allergic properties. Colon cancer prevention and therapy both benefit from the usage of LAB (Ayivi *et al*., 2020). Here we discussed about numerous beneficial effects of different types of fermented dairy products.

Alleviation of lactose intolerance

Intestinal lactase enzyme deficiency causes lactose intolerance in a large percentage of the world's population. Milk containing *L. acidophilus* helps these persons better digest lactose (Grover *et al*., 2019). In some studies, it was found that about 60-70% of adult people suffering from lactose malabsorption and found that persons who are lactose intolerant may tolerate fermented dairy products like yogurt better than the same quantity of unfermented milk (Downs *et al*., 2022; Sharanagouda *et al*., 2022). The lactic acid bacteria used to manufacture yogurt generate lactase, an enzyme that breaks down lactose, and this has been shown to aid lactose digestion (Panesar, 2011). The lactase enzyme produced by *Lactobacillus bulgaricus* and *Streptococcus thermophilus* in yogurt is effective in treating lactose intolerance (Masood *et al*., 2011). So, different fermented dairy products like yogurt, cheese, lassi, borhani, kumiss, kefir etc. could be a potential dietary use in the treatment of lactose intolerance patient.

Bacteriocin production

The development of tiny proteins called bacteriocins that inhibit related bacteria is another starting enhancer that has been researched in depth by genetic modification in LAB. Nisin, an essential antibacterial component utilized as a natural preservative in food systems, is generated by the "food grade" starter strain, *Lactococcus lactis* ssp. *lactis* (Mokoena *et al*., 2021). Nisin acts against food-borne bacteria, like *Staphylococcus* spp., *Listeria* spp. and *Clostridium* spp. (Banerji *et al*., 2022). Increased Nisin production was seen in genetically modified *Lactococcus* spp. owing to the insertion of numerous copies of genes involved in Nisin production, such as nisZ, nisRK, or nisFEG (Grover *et al*., 2019). Bacteriocins are a diverse category of antimicrobial peptides or proteins that are produced by ribosomes and secreted extracellularly, where they may kill other bacteria (Zhang *et al*., 2022). There has been an increase in both basic and applied research on lactic acid bacterium (LAB) bacteriocins over the last two decades due to their potential application as bio-preservatives in food and food products to minimize the development of food-borne bacterial illnesses (Nawaz *et al*., 2011). However, given ideal physical and chemical circumstances, bacteriocins by LAB may be generated in considerably greater quantities during in-vitro fermentations. Due to the complexity of the food matrix and the difficulty of identifying bacteriocin activity in meals, in-vitro research may mimic and analyze the in-situ functionality of bacteriocinogenic starters. The most promising method for achieving the desired fermentation and a safe end product is in-situ bacteriocin production since it allows for rapid, broad, and legal usage of bacteriocins. The generation of bacteriocins may be most important when starter or preservation cultures made from LAB are added to food. (Beshkova and Frengova, 2012). Different fermented dairy products like yogurt, cheese, lassi, borhani, kumiss, and kefir etc. can be a good source of bacteriocin and act as bio-preservatives of dairy products.

Anti-diabetic and anti-obesity

Burakova *et al*., 2022 show that LAB reduces the occurrence of diabetes and *Lactobacillus acidophilus* reduces type 2 diabetes risks and improves weight management. Species of probiotic bacteria as a result of their ability to lower cholesterol levels, *Bifidobacterium longum*, *Lactobacillus casei*, and *Lactobacillus acidophilus* have also been associated with playing a role in the prevention of obesity (Ayivi *et al*., 2020). Examples of special bacteria for obesity include *Lactobacillus acidophilus*, *Lactobacillus brevis*, *Lactobacillus casei*, *Lactobacillus fermentum*, *Lactobacillus paracasei*, *Lactobacillus rhamnosus*, and *Lactobacillus sakei*. These bacteria regulate lipid metabolism, inflammation, glucose metabolism, insulin sensitivity, and other metabolic processes (Wahid *et al*., 2021). Therefore, fermented dairy products are popularly used for the prevention and treatment of diabetes and obesity.

Anti-diarrheal

Acute diarrhea in both children and adults may be helped by taking a probiotic. Probiotics were proven to be effective in preventing diarrhea in children, as they shortened the average duration of diarrhea by 13 hours, halves the rate of treatment failure, and so on (Ayivi *et al*., 2020). There must be a steady population of microorganisms in the gut for the intestines to function normally. Several health issues affecting the digestive tract can be improved by eating fermented dairy products containing live lactic acid bacteria. These include lactose malabsorption, viral and drug-induced diarrhea, irritable bowel syndrome, inflammatory bowel disease, antineoplastic effects on human cell lines, normal blood insulin levels, and improved fat absorption (Heyman, 2000). Restoring normal intestinal flora, eliminating intestinal pathogens, bolstering intestinal barrier capacity to foreign antigens, stimulating nonspecific immunity such as phagocytosis, stimulating humoral immunity, and producing anti-inflammatory products are all ways, in which LAB accomplish these beneficial effects (Masood *et al*., 2011). Researchers have shown that the Lactobacillus strain is effective in treating both viral and idiopathic diarrhea. The probiotic strain of *Lactobacillus rhamnosus*, *Lactobacillus plantarum*, *Bifidobacterium*, and *Enterococcus faecium*, has been shown to be useful in treating children with diarrhea. *Streptococcus faecium* was effective against respiratory tract infection-associated diarrhea (Liao *et al*., 2021). It is important to encourage children to consume LAB containing foods like yogurt and fermented milk due to the beneficial effects of lactic acid bacteria in diarrheal illness, particularly in youngsters (Masood *et al*., 2011).

Anti-carcinogenic

Multiple studies have demonstrated that probiotic bacteria may inhibit the development of cancer or even reverse its course. Since lowering glucuronidase and carcinogen levels and increasing *lactobacilli* and *bifidobacteria* in the stomach minimizes the absorption of harmful mutagens, a knowledge of this phenomenon is vital (Mendoza *et al*., 2019). Intestinal instillation of probiotics, including *L. casei*, has been shown in several studies to prevent urinary bladder cancer recurrences (Ayivi *et al*., 2020). Fermented milk products' probiotic content, which includes Lactobacilli and Bifidobacteria, reduces colon cancer risk by enhancing immune cell function and changing the activity of faecal enzymes such as glucuronidase, beta-glucuronidase, azortortase, and nitroreductase (Moreno *et al*., 2007). It has been demonstrated that fermented milk products help prevent some types of cancer. Yogurt, Gouda cheese, and buttermilk all have protective effects against breast cancer (Cai *et al*., 2021). In animal studies, lactic acid bacteria have been shown to have an anti-carcinogenic effect, meaning that they either inhibit the onset of cancer or slow its progression. There was evidence of anti-carcinogenic effects of *L. acidophilus*-fermented yogurt and several hypothesized mechanisms by which lactic acid bacteria may exert their antitumor effects have been proposed (Juraskova *et al*., 2022). These include alterations in faecal enzymes thought to be involved in colon carcinogenesis, cellular uptake of mutagenic compounds, reduced mutagenicity of chemical mutagens, and tumor suppression by the improved immune response (Panesar, 2011).

Anti-cardiovascular Diseases

There has been a steady rise in the incidence of cardiovascular illnesses, making them one of the world's top killers. Most cardiovascular disorders may be avoided by taking any of the *lactobacilli* species, including *L. casei*, *L. plantarum*, *L. fermentum*, *L. rhamnosus*, *L. reuteri*, and *L. paracasei* (Forte *et al*., 2021). By reducing cholesterol levels, most *lactobacilli* are able to stave against hyperlipidemia, hypercholesterolemia, and atherosclerosis (Wahid *et al*., 2021). Probiotic lactobacilli and metabolic by-products may have cardioprotective effects and reduce blood cholesterol levels. Recent clinical trials, particularly in the treatment of hypertension, have shown the therapeutic effects of probiotics in the management of cardiovascular illnesses. Patients with hypertension have shown a decrease in their systolic and diastolic pressures (an estimated 14-6.9 mm reduction) after taking probiotics (Ayivi *et al*., 2020). Many probiotic strains have shown effects on alleviating hypertension, including *Lactobacillus plantarum*, *Lactobacillus casei*, *Lactobacillus helveticus*, and *Streptococcus thermophilus* (Thushara *et al*., 2016).

Antiviral Activity

LAB is used to treat viral infections and illnesses. It is also worth mentioning that lactic acid bacteria have a wide range of health-promoting antiviral capabilities (Agagunduz *et al*., 2022). Lactic acid bacteria are thus thought to be effective antidotes to a variety of viral diseases. In addition, the emergence of viral infections like Covid-19 has presented a formidable challenge to scientists as they search for an effective treatment to counteract this global menace. Traditional preventive antiviral medicines and drugs are often linked with a wide range of unwanted side effects, making it imperative to find a natural alternative treatment option for viral infections, such as probiotics and LAB (Ayivi *et al*., 2020). The antiviral effects of probiotics and lactic acid bacteria are exerted through several methods. Direct viral contact, production of antiviral inhibitory chemicals, immune system regulation, and stimulation are some of the well-known probiotic antiviral mechanisms. Many studies have shown that probiotic lactic acid bacteria's antiviral properties are strain-specific and dependent. *L. acidophilus*, *L. plantarum*, *L. rhamnosus*, *Lactobacillus ruminis*, *Lactobacillus delbrueckii* ssp. *bulgaricus*, *L. fermentum* have antiviral properties (Quinto *et al*., 2014).

CONCLUSION

Lactic acid bacteria are beneficial starter organisms which are crucial in the fermentation of milk and milk products. Therefore, lactic acid bacteria exert a potent antimicrobial effect against numerous microorganisms, including milk-spoiling organisms and pathogens. Furthermore, it has been speculated that the bacteriocins produced by some strains aid in the long-term storage of fermented milk and milk products. The quality of milk may be improved by fermentation, and it can also be preserved and harmful bacteria removed from milk through fermentation. In addition to food safety, the nutritional and flavour profiles of the products must fulfil modern consumers' expectations. Fermentation with LAB is a cost-effective method for preserving milk that may be used even in rural or isolated areas, and it improves the texture, flavour, and nutritional content of numerous milk products. As LAB can be used as a probiotic, it has a vital role in building a healthy microbiome and enhanced immunity to illnesses and infections. Natural therapies that are ecologically friendly while preventing viruses and food deterioration organisms are currently advocated by the enlightened food safety culture. In recent years, several biotechnological tools are also used to improve the characteristics of lactic acid bacteria to improve the quality of the fermented products produced. Recent advancements in biotechnology may be used to acquire a better understanding of the influence of LAB in different body functions. Moreover, health education must include educating communities about the advantages of consuming fermented milk and milk products.

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