

Article

The Role of Fermented Dairy Products in Human Health

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Abstract

Fermented dairy has a profound effect on human health. Fermented dairy foods affect human health through the secretion of biologically active compounds through microorganisms' protein digestion and the interaction between beneficial microbes in them and the intestine. An unbalanced diet and an unhealthy lifestyle are directly linked to inflammatory bowel disease, irritable bowel syndrome, diarrhea, hypersensitivity, lactose intolerance, and gastroenteritis. Studies have shown that fermented dairy products (fermented milk, yogurt, cheese, koumiss, kefir) helped in the immune response against pathogens by adding antioxidants, anti-microbials, anti-fungals, anti-inflammatory, anti-diabetic and anti-atherosclerotic agents. Fermented products have also been widely used as the most effective means of delivering beneficial or digestible probiotic microbes. Fermented milk has many health benefits. It relieves the symptoms of lactose intolerance and is used to prevent colon cancer. Several studies have indicated the ability of lactic acid bacteria to prevent and inhibit the growth of cancer cells. Curd also has a laxative effect and facilitates the passage of waste, preventing the risk of constipation and its complications, such as diverticulosis and colon cancer. The results of scientific research have shown the ability of the metabolites found in fermented milk and other foods containing it to further improve the immune capabilities of the intestine through increasing immune proteins IGA, which helps humans in the prevention and protection of diarrhea and intestinal infections, especially in children, Fermented milk is also used to reduce the severity of the winter cold. It was a vital stimulant in treating patients with colds, influenza, and colds. The results showed a remarkable difference in the ability of these vital stimulants to reduce the severity and duration of colds and colds. However, they did not show an effect in the treatment of influenza. Fermented milk reduces allergy to milk protein, as many people suffer from milk protein allergy. This article focuses mainly on the health effects and the most important functional components of fermented milk, thus providing an excellent opportunity to develop functional dairy products supported by new lactic acid bacteria that support human health. This paper provides an overview of different aspects of the research on microorganisms present in dairy products in the light of their impact on human health.

Keywords: microbes, colon cancer, fermented, Human.

Introduction

Fermented dairy products play a significant and beneficial role in the diet. The fermented dairy industry and its products are among the most developed and best-organized food industry sectors. The establishment of the International Dairy Federation in 1903 advanced the dairy industry worldwide. This is because he provided many seminars and workshops to discuss the main issues facing the dairy industry globally and locally, in addition to sponsoring international cooperation in this field. The primary objective of fermentation is to increase the shelf life of perishable foods and improve the organoleptic and physical properties, digestibility, and bioavailability of nutrients ¹. Among fermented foods, fermented dairy products have played a significantly beneficial role in the human diet since ancient times and in recent times. It has attracted scientific interest due to its health-promoting effects ¹³.

Milk fermentation is a natural phenomenon caused by lactic acid-producing microorganisms. This acid raises the acidity of milk. Thus, it leads to removing toxic or anti-nutritional factors, such as lactose and galactose, from fermented milk to prevent lactose intolerance and its accumulation and convert organic compound molecules into simple and easily digestible compounds. Fermented dairy foods affect human health through the secretion of biologically active compounds through microorganisms' protein digestion and the interaction between beneficial microbes in them and in the intestine. Fermented products have also been widely used as the most effective means of delivering beneficial or digestible probiotic microbes. Fermented products are considered one of the preferred products by consumers and are preferred in terms of sensory qualities during consumption. Studies have shown that the fermented materials of dairy products (fermented milk, yogurt, cheese, koumiss, kefir) helped in the immune response against pathogens by adding antioxidants and anti-microbials anti-fungals, anti-inflammatory, anti-diabetic and anti-atherosclerotic. An unbalanced diet is directly related to inflammatory bowel disease (IBD), diarrhea, hypersensitivity, irritable bowel syndrome, lactose intolerance, gastroenteritis ... etc. ² To understand the health mechanisms of eating fermented dairy products and types of milk with different fat percentages, this feasibility can be included in two aspects:

The aspect of healthy nutrition is providing the body with nutrients that are useful for its growth and the activity of its organs, and the effects of the different production processes of dairy products on the composition and homogeneity of the nutrients of the original milk components and in the process of digesting them in the intestines and the ease of absorption of the nutrients available in them.

The other aspect is the prevention or treatment of several acute and chronic diseases that may affect all parts of the body, especially the role of bacteria added in fermented dairy products on colonies of friendly bacteria in the intestines, on the body's immune system, on inflammatory processes in the body, on cases of allergies and microbial infections in different areas of the body ³

Physiological Effect on Health

Fermented foods contain good organisms that contribute to the modification of the physiological balance of the host by bioactive molecules. The microorganisms present in fermented dairy products, especially lactic acid bacteria, can produce large quantities of secondary metabolites with excellent health benefits and substances

with antimicrobial activity, in addition to their ability to increase the levels of many biologically active compounds such as vitamins, antioxidants compounds, peptides, etc⁴ Fermented dairy products are more potent than other dairy products in increasing nutrient absorption. Its probiotics have a beneficial effect on intestinal bacteria and intestine inflammation. Microorganisms also work during fermentation in the production of enzymes lactase, protease, lipase, and amylase that improve the nutritional value of the materials while increasing the health benefits for consumers. On the other hand, lactate, ethanol, pyruvate, and succinate produced by lactic acid bacteria are used by some bacteria in the intestine to produce and generate short-chain fatty acids. The content of the gut maintains colonic mucosa and aging-promoting cell death⁵

Fermented Milk

Fermented or sour milk has played an essential role in human nutrition worldwide. These products have a distinctive thick texture and can be kept in cold rooms for several weeks or months. It was found that microorganisms in fermented milk make milk reduce colitis symptoms in sick people. Oocytes of many types of bacteria manufacture fermented milk. Among the microorganisms involved in fermentation are lactic acid bacteria, including *Lactobacillus*, *Lactococcus*, *Streptococcus*, *Leuconostoc*, and *Pediococcus* genera that increase fermented milk with a distinctive flavor, texture, and high nutritional value Figure 1. ^{6,7, 8} confirmed that fermented milk improves the diet caused by high cholesterol and helps maintain the health of the liver and kidneys. He also confirmed that it reduces the level of glucose in the blood. ⁹ proved that fermented milk reduces gastritis due to reducing the response of the intestinal membranes to inflammation by the metabolites resulting from the fermentation. Showed that fermented camel milk has many biological and functional properties as antioxidants, anti-inflammatory, and antiviral¹⁰.

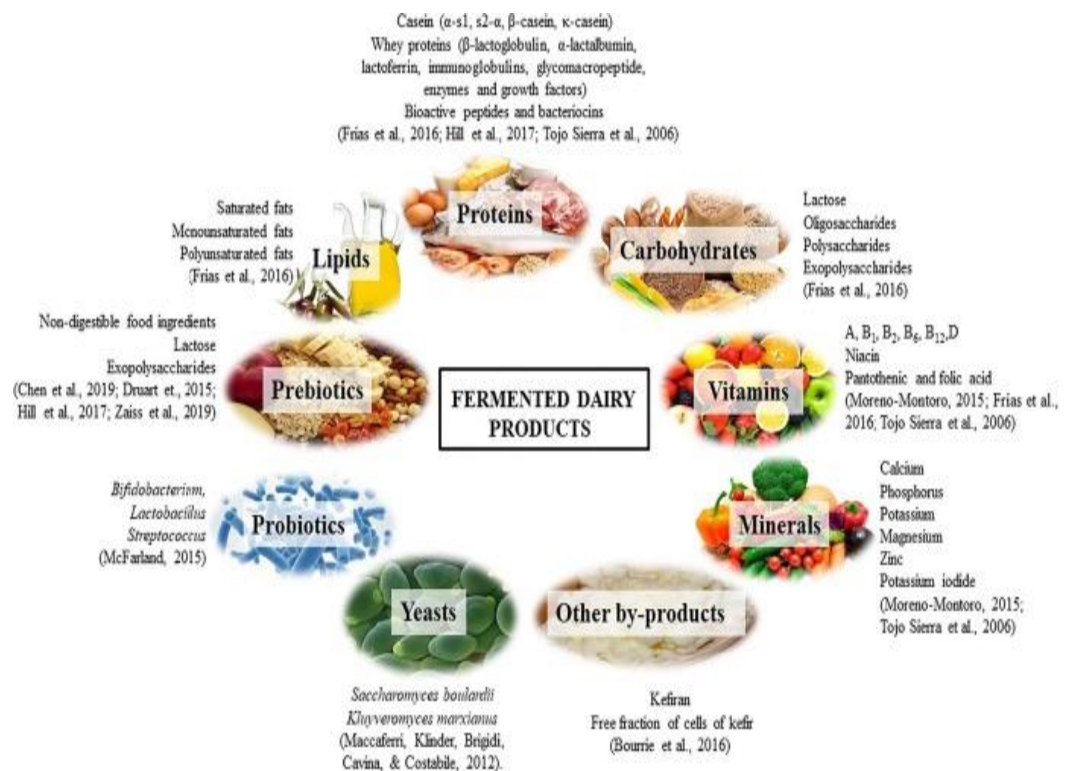


Figure 1. Main components of fermented milk.

The Most Important Functional Components of Fermented Milk

Fermented milk contains many important nutrients to human health, as these elements are improved after the fermentation process by lactic acid bacteria.

Lactose

Lactose is fermented into lactic acid, causing the acidity to rise. This affects the physical properties of milk proteins, especially casein. This increases its digestibility, improves calcium absorption and other minerals, and prevents the growth of harmful bacteria due to the low lactose content. This type of food is considered beneficial for people with lactose intolerance ⁽¹⁵⁾. Lactose is one of the main carbohydrates available in fermented dairy products. It accounts for 98% of the carbohydrates in natural yogurt. It turns lactose into glucose and galactose by the enzyme B.galactoidase in the intestine. In addition to the oligosaccharides, disaccharides, and polysaccharides produced by the lactic acid bacteria ¹¹

Proteins

Fermented milk contains a high percentage of proteins of high nutritional value because it contains essential amino acids. The activity of lactic acid bacteria leads to the hydrolysis of protein by protease enzymes, which produce some amino acids and peptides that are biologically active, such as casomorphins, cytokinins, immunopeptides, lactoferrin, lactoferricin, and phosphopeptides. Many of the peptides within the original protein sequence are inactive and can be released by enzymatic hydrolysis of the protein, which is instrumental in immunomodulation, antimicrobial activity, anticoagulant activity, blood pressure regulation, and mineral and vitamin binding ¹² Fermented milk is also a rich source of whey protein lactalbumin, -lactoglobulin, lactoferrin, lactoperoxidase, which have anti-cancer effects and various effects on the digestive system's functions the biological value of the protein ¹³ figure 2.

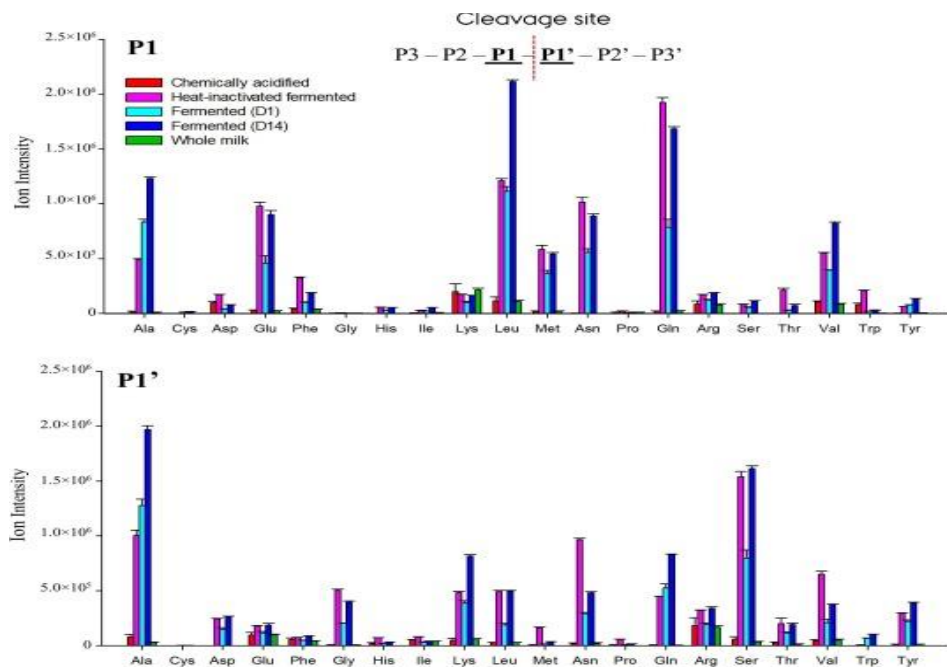


Figure 2. Total ion intensity of peptides distributed according to their P1 and P1' cleavage site amino acid in yogurt and milk samples.

Fats

Milk fat contains a high percentage of lauric, myristic, and palmitic saturated fatty acids, which raise cholesterol in the blood and the risk of heart disease and atherosclerosis. The fermentation process of milk causes the digestion of fats.

Moreover, fermented milk contains components with protective effects such as linoleic acid and antioxidants carotene and fat-soluble vitamins A and D, which are anti-carcinogenic ¹⁴. ¹⁵ confirmed that yogurt contains 95% triglycerides, 72% saturated, 25% monounsaturated, 3% polyunsaturated fatty acids, and high linoleic acid and fat-soluble vitamins.

Vitamins and Minerals

Fermented dairy products are rich in available vitamins and minerals such as vitamin A, B1, B2, B6, B12, niacin, folic acid, pantothenic acid, vitamin D, calcium, phosphorous, zinc, magnesium, iodine, and potassium ¹⁶

Probiotics and Prebiotics

Probiotics are microorganisms that have a beneficial effect on the host by improving intestinal microbial balance. As for prebiotics, they are non-digestible food components that have a beneficial effect by selectively stimulating the growth or activity of one or a specific number of bacteria in the colon, which improves the host's health, such as lactose, galactooligosaccharides, polydextrose, sialyl lactose and sialyl lactose. Synbiotics also use probiotics and prebiotics together ¹ Fermented milk is one of the best nutritional components, a source of probiotics to prevent allergies, treat Irritable Bowel Syndrome, and treat inflammatory bowel diseases and diarrhea ¹⁷ Kalash ¹⁸ confirmed that intestinal bacteria produce biologically active compounds that regulate intestinal health, especially short-chain fatty acids such as butyrate, propionate, acetate, and lactate, which are produced by the fermentation of carbohydrates and unsaturated fatty acids. Short-chain acids affect intestinal cells and control mucosal infections and colorectal cancer ³.

Antioxidants

Oxidative damage is caused by free radicals that are by-products of physiological reactions inside the human body, such as caloric generation and lipolysis. One of the food's most significant good properties is its antioxidant activity ¹⁴ It is protective against oxidative damage in the human body involved in the emergence of chronic diseases for most ages associated with the diet ¹⁶. The human body can protect itself from oxidative damage through enzymatic systems like superoxide dismutase, glutathione peroxidase, catalase, and non-enzymatic antioxidant compounds such as tocopherols and vitamin C, phenolic compounds and carotenoids, ¹⁵.

Product	Lactic acid bacteria	Health effect	active compound
fermented milk	<i>L. rhamnosus</i> MTCC 5897 <i>L. rhamnosus</i> MTCC 5957	Antioxidant effect High cholesterol	Probiotic
fermented milk	<i>Lactobacillus helveticus</i>	Stomach and intestinal disorders	Probiotic Peptides
Cheese	<i>L. chungangensis</i> CAU28	Immunology and dermatitis	short-chain fatty acids butyrate, acetate, and propionate gut microbiota
Cheddar cheese	<i>L. plantarum</i> K25	Lower cholesterol and heart health	Probiotic peptides
Kefir	<i>Lactobacillus lactis</i> subs., <i>Leuconostoc</i> subs., <i>Streptococcus thermophilus</i> , <i>Lactobacillus</i> subs., and yeast of kefir	Colitis	microbial population of the kefir,

Goat's milk	<i>Pediococcus pentosaceus</i>	Antioxidant	Phenolic compounds and peptides
fermented milk	<i>Lactobacillus plantarum strain AF1</i>	Antioxidant	Phenolic compounds and peptides
Yogurt	<i>Streptococcus salivarius subsp. thermophilus strain fmb5</i>	Anti-hypertensive	peptides and Aminobutyric Acid
Yogurt-Like Beverages	<i>Lb. rhamnosus SP1</i> <i>Lb. Plantarum</i>	Improve protein digestion	Probiotic peptides polysaccharides
Yogurt	Mixture of <i>L. casei</i> <i>L. bulgaricus</i> <i>S. thermophilus</i>	Antibiotics associated with diarrhea in adults	Probiotic
fermented milk	<i>Bifidobacterium animalis DN-173 010</i>	Irritable Bowel Syndrome	Probiotic
Yogurt	<i>Lactobacillus lactis subs</i>	lactose intolerance allergy	polysaccharides
fermented milk	<i>Lactobacillus casei subsp Shirota</i>	Improve protein digestion	
fermented milk	<i>Lactobacillus lactis subs</i>	stomach infections	Metabolites resulting from fermentation
Fermented goat's milk	<i>Lactobacillus lactis subs</i>	Malnutrition	amino acids short chain
Probiotic Yogurt	<i>Lactobacillus acidophilus Lactobacillus casei</i>	Antioxidant	Peptides

Table 1. Biologically active components in fermented dairy products.

Yogurt

Yogurt is a product of milk fermented by adding some types of bacteria that produce lactic acid, which gives it a sour taste and a thick texture. These types of bacteria are called probiotics; the most important are *Lactobacillus bulgaricus* and *Streptococcus thermophiles*. Yogurt is considered a healthy fermented food due to its good digestibility and the availability of nutrients such as proteins of high nutritional value and energy and a source of essential amino acids and micro and macronutrients required for health. All of which may help maintain the balance of bacteria needed to boost the immune system and promote a healthy digestive system. ¹⁵ yogurt is a good source of calcium, as calcium is necessary for the health, growth, and maintenance of bones and teeth. It is also easily absorbed by the body and essential for blood clotting, wound healing, and maintaining normal blood pressure. Yogurt consumption also improved protection against risk factors such as cardiovascular disease and improved anti-diabetic properties ¹⁶. ⁴ confirmed that daily and healthy consumption of yogurt reduces the microbial load in the intestine, enhances the immune system in women, and reduces infections in pregnant women. As shown, yogurt relieves irritable bowel syndrome symptoms such as abdominal pain, constipation, and flatulence after six weeks of consumption.

Cheese

Cheese is a fermented dairy product that contains a wide range of beneficial microorganisms. It is less acidic but has a high storage capacity, a solid consistency, a higher percentage of fat, and higher nutritional components than yogurt. These qualities protect the probiotic bacteria during storage and passage through the gastrointestinal tract ⁷. Cheese has the highest shelf life among fermented dairy products, and cheese provides an environment for the long-term survival of *Bifidobacterium* that has helped preserve its organoleptic properties ¹⁸. Cheese is a good source of calcium, an essential nutrient for healthy bones and teeth, blood clotting,

wound healing, and maintaining normal blood pressure. It also contains protein, magnesium, and zinc for growth, in addition to vitamins A, D, and K, which are necessary for children and young people to prevent osteoporosis. It should also be noted that calcium plays an essential role in the formation of teeth, as studies have shown that eating cheese can raise the pH level in the teeth, which protects against decay. Cheese is a good source of some antioxidants. Although cheese usually contains a high percentage of cholesterol and sodium, which may lead to problems in the heart and blood vessels, some studies have shown that some antioxidants found in cheese may reduce the harmful effect of sodium and cholesterol on the human body. Another study showed that cheese contains substances that stimulate the production of the antioxidant glutathione in the brain, promoting brain health and reducing age-related oxidative stress in brain tissue ²⁰. Cheese maintains a healthy digestive system. Peptides, minerals, and other bioactive compounds primarily prevent and treat diseases and enhance anti-cancer properties ²¹. Whey contains about 20% of the total milk protein and has high nutritional value. As well as biological properties, whey protein is an essential source of bioactive peptides with beneficial effects on health (e.g., antioxidant, anti-diabetic). The microbes in cheese whey can degrade proteins and generate peptides through fermentation ¹⁸

Koumiss

It is a fermented dairy drink of ancient origin, traditionally made from mare's milk. It originated from nomads in Central Asia and spread widely in Russia, Turkey, Kazakhstan, and West Asian regions for its health potential. It has a mild alcoholic and sour taste. Koumiss and kefir are roughly related. Both are prepared from yeast and lactic acid fermentation, but it is made from a liquid starter, unlike kefir grains. Koumiss undergoes two types of fermentation: lactic acid fermentation and alcoholic fermentation ¹¹. Mare's milk has a strong laxative effect, so it is not recommended to eat it raw. It also contains a higher percentage of lactose than cow's milk. The lactic acid bacteria ferment lactose into lactic acid, ethanol, and carbon dioxide in koumiss. The starter koumiss contains *L.delbrueckii* subsp. *bulgaricus*, *L. acidophilus* and the lactose-fermenting yeast *Saccharomyces* spp. *k.Marxianus* var. *marxianus* and *Candida koumiss*, as for the non-fermenting yeast cartilaginous *Saccharomyces* and the non-fermenting carbohydrate *Mycoderma* spp. It has been scientifically proven that koumiss has beneficial effects as a nutraceutical product for intestinal health and stimulates intestinal immune response. It also has anti-bacterial and anti-fungal functions. ⁴. Kumys is considered an easy-to-digest food due to its high content of whey protein and casein and its spongy protein structure that enhances digestibility. ⁵. treatment of chronic diseases of the digestive system. It was found ³ that sixty days of koumiss consumption by patients alleviated the symptoms of the chronic disease of atrophic gastritis. It also reduces blood cholesterol and platelet levels by modifying the gut microbiota ³. It also has a beneficial effect in the treatment of chronic digestive diseases. In addition, it has positive effects on the kidneys, endocrine glands, blood-forming organs, digestive system, immunity, heart, and blood vessels. In addition, it has therapeutic effects on multiple disorders, including anemia, vitamins, and intestine disorders

Kefir

It is a fermented milky drink that originated in the North Caucasus and the mountains of Tibet thousands of years ago. It is different and less popular than other fermented dairy products, such as yogurt and cheese. It is manufactured through the traditional fermentation of milk using a kefir seed starter containing bacteria and yeast that live in symbiosis, affecting the product's sensory qualities. Cow, goat, or sheep's milk is used in its manufacture and has aroused the scientific

community's interest due to its beneficial effects on health ⁴. Kefir grains mainly contain lactobacillus kefir and some genera *Leuconostoc*, *Lactococcus* and *Acetobacter*, lactose-fermenting *Kluyveromyces marxianus* non-fermenting *Unixporus*, *Saccharomyces cerevisiae*, and exiguous *Saccharomyces*. Kefir contains milk protein of 2.7%, milk fat of less than 10%, lactic acid of 0.6%, and the total microorganisms are 10 Cfu/ml. Yeast should not be less than 10 Cfu/ml and has a sour flavor. Yeast produces vitamins, amino acids, and other essential growth factors that help promote bacterial growth. The components of kefir contain many biomedical properties that help maintain the immune response and many factors related to health. ⁷ thought that the weekly consumption of kefir for those suffering from metabolic syndrome showed a change in the microbiota with an increase in Actinomycetes without any change in Bacteroidetes and Proteobacteria.

Buttermilk

Buttermilk is the by-product produced after cream or yogurt has been shaken and turned into butter. It is either sour when using fermented cream or fresh when using fresh cream, called sweet milk. It contains all the components of full-fat milk from protein, lactose, and minerals, except that it is low in fat, and its composition is very similar to that of filtered milk, resulting from the manufacture of cream to a large extent. Acidophilus starter or cream can be added, resulting in a fermented drink with great therapeutic power for digestive diseases. Green coffee contains high amounts of fatty granule membranes and whey proteins, which benefit human health. It reduces cholesterol and low-density lipoproteins (LDL) and increases the concentration of high-density lipoproteins (HDL), thus reducing the risk of coronary heart disease ⁶. Buttermilk's proteins and sphingosine-1-phosphate reduce fat accumulation in liver and kidney tissues and reduce programmed cell death due to toxicity caused by fat accumulation ⁷.

Conclusion

Fermented dairy products significantly impact human health through biologically active compounds produced by microorganisms. These products are widely used and considered the optimal means to deliver beneficial probiotics to the human body. Studies showed that the chemical compounds produced through fermentation of dairy products (fermented milk, yogurt, cheese, kumis and kefir) support the immune system against many diseases as these compounds constitute a variety of antioxidants, antibiotics, anti-fungal, anti-inflammatory, anti-diabetes and anti arteriosclerosis. Fermented dairies have many health effects. It works to reduce the symptoms of lactose intolerance, prevents colonic cancer (since many studies indicate the role of yogurt microorganisms in preventing cancerous cells) and averts constipation and its complexation. Fermented dairies are also used to lower the severity of influenza, common cold and rhinitis because of it's role as biocatalysts. In addition, it decreases sensitivity to milk protein as many patients suffer high sensitivity to that protein. Also, having fermented dairy products with lower fats will diminish the probability of heart disease. In conclusion, dairy products can be developed and modified to produce more specialized products supported by lactic acid to preserve human health.

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