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The Role of Lactic Acid Bacteria in Milk Preservation

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ABSTRACT

LAB have been extensively used in food fermentation, including the production of milk products. Its proteolitic activity is very important in producing flavor compounds of end product. The species used for these applications typically belong to the group of gram-positive bacteria including the genera Lactobacillus, Lactococcus, Leuconostoc, Pediococcus, and Streptococcus. They are recognized for their fermentative ability and thus enhancing food safety, improving organoleptic attributes, enriching nutrients and increasing health benefits. Proteolytic system of LAB is important for the growth of microorganisms and it is involved in casein utilization within LAB cells and gives contribution to the development of organoleptic properties of fermented milk products. Milk fermentation is profitable in terms of improving milk quality, preservation and decontamination of toxins, often found in food. This study concludes that fermentation with LAB is a cheap and effective milk preservation method that can be applied even in more rural/remote places; hence, education of communities about benefits of consuming fermented milk and milk products needs to be part of health education.

Keywords: Milk, Food, Microorganisms, Fermentation, Preservation, Bacteria

INTRODUCTION

Lactic acid bacteria (LABs) are industrially important organisms used for the production of milk and milk products like yoghurt, cheese, buttermilk and kefir. The species used for these applications typically belong to the group of gram-positive bacteria including the genera Lactobacillus, Lactococcus, Leuconostoc, Pediococcus, and Streptococcus. They are recognized for their fermentative ability and thus enhancing food safety, improving organoleptic attributes, enriching nutrients and increasing health benefits [1]. Due to the characteristics of milk that is highly perishable, the main purpose of milk fermentation using LAB is to prolong its shelf-life as well as to preserve the nutritious component of milk. It is also recognized that fermentation of milk using LAB will undoubtedly produce good quality of products with highly appreciated organo-leptic attributes. Recently, there is a growing interest to develop a variety of fermented milk products for other beneficial purposes, particularly for health purposes and preventing of toxins produced by food-borne pathogens and spoilage bacteria that enter human body [2]. The presence of LAB in milk fermentation can be either spontaneous or inoculated starter cultures. Milk itself is known as one of the natural habitats of LAB [3]. In general, the technology of milk fermentation is relatively simple and cost-effective. On the other hand, standardized fermented milk products are produced and manufactured in large-scale production under controlled conditions and become an important industrial application of LAB as starter cultures. There are some important features of LAB starters in fermented milk products. A single potential starter culture will dominate and reduce the diversity of microorganisms in fermented milk products compared to that of products under natural fermentation. Using lactic acid bacteria in milk fermentation and preservation is indispensable to improve milk palatability and quality. Based on this, this paper appraised the role of lactic acid bacteria in milk.

Role of Lactic Acid Bacteria in Milk Fermentation

LAB are widespread in nature and predominate of microflora in milk and milk products; many species are involved in the daily manufacturing of dairy products [4]. The lactic acid bacteria used in the dairy fermentation can

roughly be divided into two groups on the basis of their growth optimum. Mesophilic lactic acid bacteria have an optimum growth temperature between 20 and 30°C and the thermophilic have their optimum between 30 and 45°C. Traditional fermented products from sub-tropical countries harbor mainly thermophilic lactic acid bacteria, whereas the products with mesophilic bacteria originated from western and northern European countries. The lactic acid bacteria can be mainly divided into two groups based on the end-products formed during the fermentation of glucose. Homofermentative lactic acid bacteria such as Pediococcus, Streptococcus, and Lactococcus produce lactic acid as the sole product of glucose fermentation. Heterofermentative lactic acid bacteria such as Weissella and Leuconostoc produce equimolar amounts of lactate, CO2 and ethanol from glucose [5].

LAB have been extensively used in food fermentation, including the production of milk products, and its proteolitic activity is very important in producing flavor compounds of end product [6]. Proteolytic system of LAB is important for the growth of microorganisms and it is involved in casein utilization within LAB cells and gives contribution to the development of organoleptic properties of fermented milk products [6]. Milk fermentation process has relied on the activity of LAB, which play a crucial role in converting milk as raw material to fermented milk products. In milk fermentation industry, various industrial strains of LAB are used as starter cultures. Several behaviors as the characteristics of each individual selected strains of LAB has been established and used in the production of fermented milk products industrially. The most important properties of LAB are their ability to acidify milk and to generate flavour and texture, by converting milk protein due to their proteolytic activities [7]. The mild acid taste and pleasant fresh are characteristics of fermented milk products such as yoghurt and cheese.

Health Impact of Lactic Acid Bacteria

The high demand of fermented milk products is due to the health property generated from consumption of fermented milk products. Fermented milk products are reported to contribute to human health through several mechanisms. Certain lactic acid bacteria strains of the genera Lactobacillus, are utilized as health promoting bacteria, while certain Lactobacillus strains like L. helveticus are believed to produce bioactive health beneficial peptides from casein protein of milk and showed effect of antihypertensive, immune modulator activity, anticancer and calcium binding ability. L. helveticus is known as one of LAB which has efficient [8].

Table 2. Health benefits when milk is fermented.

Effect of fermentation	Changes in milk	Effect on health
Increase in lactic acid bacteria levels	Reduced lactose content in milk Reduced content of bad bacteria	No diarrhea and bloating Improved gut health Prevention of protection from bacterial vaginosis and fungal infections in women Ability to digest remaining lactose in the fermented milk and use as energy source
Breakdown to shorter chain proteins	Identification of casein peptides and whey peptides with functional properties	Easier digestion Some with antihypertensive effects Some with pain relief effects Some with immune enhancing properties Some with calcium binding bone building properties
Increased acidity	Sharpness of taste	Prevents harmful bacterial growth in milk

Source: http://whqlibdoc.who.int/publications/2003/9241591196.pdf and ftp://ftp.fao.org/docrep/fao/007/y5686e/y5686e00.pdf

Antimicrobial Present in Lactic Acid Bacteria

The preservative action of starter culture in food is to the combined action of antimicrobial metabolites produced during the fermentation process. These include many organic acids such as lactic, acetic and propionic acids produced as end products which provide an acidic environment unfavourable for the growth of many pathogenic and spoilage microorganisms. Acids are generally thought to exert their antimicrobial effect by interfering with the maintenance of cell membrane potential, inhibiting active transport, reducing intracellular pH and inhibiting a variety of metabolic functions [9]. Some of the inhibitory compounds against other bacteria include hydrogen peroxide and bacteriocins. One of the arguments supporting the use of LAB fermentation is to prevent diarrheal diseases because they modify the composition of intestinal microorganisms and by this, act as deterrents for pathogenic enteric bacteria. LAB bacteria also produce fungal inhibitory metabolites. These are mainly organic acids, which include propionic, acetic and lactic acids [10]. Thus, LAB is applied as a hurdle against non-acid tolerant bacteria, which are ecologically eliminated from the medium due to their sensitivity to acidic environment. Also, fermentation has been demonstrated to be more effective in the removal of Gram-negative than the Gram-positive bacteria, which are more resistant to fermentation processing. As such, fermented food can control

diarrhoeal diseases in children. Moreover, LABs are also known to produce protein antimicrobial agents such as bacteriocins. Bacteriocins are peptides that elicit antimicrobial activity against milk spoilage organisms and food borne pathogens, but do not affect the producing organisms. LAB also synthesizes other anti-microbial compounds such as, hydrogen peroxide, reuterin, and reutericyclin [11]. Other applications of LAB include their use as probiotics that restore the gut flora in patients suffering from diarrhea, following usage of antibiotics that destroy the normal flora. In this manner, fermented food is used to prevent and to alleviate diarrhea. In addition, the consumption of food products rich in LAB helps to alleviate constipation and abdominal cramps. Generally, bacteriocins are antimicrobial proteinaceous compounds that are inhibitory towards sensitive strains and are produced by both Gram-positive and Gram-negative bacteria [12].

Lactic Acid Bacteria as Functional Starter Culture

The most important application of lactic acid bacteria is their use as starter strains in the manufacture of various fermented dairy products. In particular, Streptococcus thermophilus, L. lactis, L. helveticus, and L. delbrueckii subsp. Bulgaricus are widely used as milk starter cultures. S. thermophilus and L. bulgaricus are the two bacteria required to make yoghurt and Lactobacillus casei is frequently found in cheeses. The proper selection and balance of lactic acid bacteria used for starter culture is critical for the manufacture of milk fermented food products with their desirable texture and flavor [13]. Starter cultures of LAB can be either mesophilic from the genera of Lactococcus and Leuconostoc or thermophilic from the genera of Streptococcus and Lactobacillus [14]. Among species, L. lactis, S. thermophilus and L. helveticus are intensively studied. L. helveticus is specialized milk species and belong to the member of dairy niche species. Several cheese products are based on L. helveticus as starter.

Preservative Ability of Lactic Acid Bacteria

Milk is a highly perishable food raw material. Its transformation into stable milk products provides an ideal vehicle to preserve its valuable nutrients, and making them available throughout the year. It is known that while unprocessed milk can be stored for only a few hours at room temperatures, cheeses may reach a shelf live up to 5 years (depending on variety). Fermentation with LAB is a cheap and effective milk preservation method that can be applied even in more rural/remote places, and leads to improvement in texture, flavor and nutritional value of many milk products. LAB have a long and safe history of application and consumption namely in cheese processing [15]. Fermentation makes the milk palatable by enhancing its aroma and flavor. These organoleptic properties make fermented food more popular than the unfermented one in terms of consumer acceptance. The lowering the pH to below 4°C through acid production, inhibits the growth of pathogenic microorganisms which can cause food spoilage, food poisoning and disease [16]. For example, LAB bacteria have antifungal activities. By doing this, the shelf life of fermented food is prolonged. This is because the sheer overgrowth of desirable edible bacteria in food outcompetes the other non-desirable food spoilage bacteria. Thus, LAB fermented foods have lactic acid as the main preservative since lactic acid bacterial growth is accompanied by the production of lactic and acetic acids with decrease in pH and increase in titratable acidity. Using LAB fermentation for detoxification is more advantageous in that it is a milder method which preserves the nutritive value and flavor of decontaminated food [17].

CONCLUSION

Lactic acid bacteria have an essential role in milk fermentation and preservation since lactic acid bacteria display numerous antimicrobial activities in fermented foods. This is mainly due to the production of organic acids. Therefore, lactic acid bacteria exert strong antagonistic activity against many microorganisms, including milk spoilage organisms and pathogens. In addition, some strains may contribute to the preservation of fermented milk by producing bacteriocins. Milk fermentation is profitable in terms of improving milk quality, preservation and decontamination of toxins, often found in food. Fermentation with LAB is a cheap and effective milk preservation method that can be applied even in more rural/remote places, and leads to improvement in texture, flavor and nutritional value of many milk products. Education of communities about benefits of consuming fermented milk and milk products needs to be part of health education.

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