A Review on Probiotic Dairy Products as Functional Foods
Reported from Iran

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Abstract: In recent years, the consumption and importance of functional foods have increased. Functional foods have therapeutic effects beside their nutritional importance. Probiotic foods and enriched dairy products are among the most important functional foods, especially because of their health promoting effects. Therefore many studies have been published around the presence and the role of probiotics and their viability in dairy food such as yogurt, cheese and ice cream. The focus of this article is to review the application of probiotic microorganisms in dairy products and methods for increasing their viability in dairy food products from Iran.

Keywords: Functional foods; Dairy product; Probiotics; Iran

1. Introduction

According to the FDA functional foods and beverages have high nutritional value and also medicinal properties and many features for consumer health (IFIC, 2007). Nowadays, the demand for functional foods has increased significantly. According to a study by IFIC in 2007, more than 80% of the participants consumed these foods or they had tendency to use them.
Growing need for functional foods due to increased consumer awareness is one of its benefits (IFIC, 2007).

The recently extended range of functional foods include probiotic, prebiotics and synbiotics foods. In addition, foods enriched with antioxidants, Isoflavones, Phytosterols, Anthocyanins and fat and sugar reducing foods are considered as functional foods. It is estimated that probiotic functional foods comprise 60% to 80% of total functional foods. The probiotic dairy products have a special role among functional foods and they form the major part of the functional foods’ market especially in the last decades (Homayouni, 2014). Probiotic dairy products contain lactic acid bacteria (LAB) or Bifidobacterium spp. Other dairy products are enriched with prebiotics, fiber, calcium, omega-3, acethanol and bioactive peptides from LAB (Homayouni, 2014). In current article, probiotics and probiotic-enriched dairy products will be reviewed as functional foods in Iran.

2. Probiotics

2.1. Probiotics

Probiotics are non-pathogenic living microorganisms (such as lactic acid bacteria and yeasts used in fermentation procedures) which can be used in foods in order to improve the normal flora of host intestine. (FAO/WHO, 2001). Probiotics must be safe and sufficient at the time of consuming. Therefore, it is essential to select the species that have the ability to survive a long time to maintain their roles in industrial processes (Homayouni, 2014).

2.2. Types of probiotics

Although several species and strains of microorganisms are known as probiotics but most probiotic bacteria which are used in the foods are lactic acid bacteria (LAB) that mainly belong to Lactobacillus spp. and Bifidobacterium spp. Other probiotics include other lactic acid bacteria such as Enterococcus faecalis, Enterococcus faecium, Lactococcus and Sporolactobacillus inulinus, and also non-lactic acid bacteria including Bacillus cereus, Saccharomyces cerevisiae and boulardii, Escherichia coli and Propionibacterium freudenreichii (Homayouni, 2014).

Probiotic bacteria which were isolated from Iranian dairy products are described in Table 1. Lactobacillus and Bifidobacterium genera are among General Recognized As Safe (GRAS) foods, as they have a history of safe usage and are non-pathogenic. Both are part of human intestinal normal flora, Lactobacillus spp. is isolated from small intestine and Bifidobacterium spp. from large intestine (Homayouni, 2014).
Table 1. Probiotic microorganisms isolated from dairy products in Iran

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Type of probiotic microorganisms</th>
<th>Researchs and date of publishing</th>
</tr>
</thead>
</table>
| Buffalo milk                     | *Lactobacillus paracasei*  
*Lactobacillus pentosus*  
*Lactobacillus brevis*  
*Pediococcus acidilactici* | Iranmanesh, 2013                                                      |
| Azerbaijan traditional cheese    | *Lactobacillus casei*  
*Lactobacillus brevis*  
*Lactococcus lactis*  
*Leuconostoc dextranicum*    | Bonyady, 2011                                                          |
| Azerbaijan traditional cheese    | *Lactobacillus fermentum*  
*Lactobacillus plantarum* | Mirzaee, 2013                                                          |
| Pasteurized yogurt               | *Lactobacillus bulgaricus*  
*Streptococcus thermophiles* | Bonyady, 2011                                                          |
| Rafsanjan traditional yogurt     | *Lactobacillus brevis*  
*Lactobacillus casei*  
*Lactobacillus plantarum*  
*Lactobacillus acidophilus*  
*Lactobacillus rhamnosus* | Farah bakhsh, 2012                                                     |

2.3. Health effects

Health benefits of probiotics are maintaining normal flora, protection of the digestive tract, improvement of the immune system, reduction in blood cholesterol levels and blood pressure, anti-cancer activity and improvement of nutrients absorption. Probiotics are involved in the treatment of diseases such as diarrhea in children, osteoporosis, some types of allergies, of diarrhea caused by antibodies, and constipation. According to the studies, consumption of fermented yogurt with *Lactobacillus* strains can reduce the level of blood cholesterol (Homayouni, 2014).

Many studies have investigated the beneficial effects of probiotics consumption in Iran. In a study were observed a reduction in blood sugar levels and increases the antioxidant activity by consuming probiotic yogurt (Ejtahe et al, 2011). In another study by the same author, it was demonstrated that *Lactobacillus acidophilus* and *Bifidobacterium lactis* can improve cholesterol
and LDL levels in diabetic patients and it is also effective in improving the heart disease (Ejtahed et al, 2011). Table 2 contains the list of beneficial effect of probiotics on different diseases.

Table 2. Examine the health benefits of probiotic microorganisms on disease

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Type of probiotic microorganisms</th>
<th>Beneficial effect on the disease</th>
<th>Researchs and date of publishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iranian traditional cheese</td>
<td>Lactobacillus plantarum</td>
<td>Stomach ulcer</td>
<td>H. Abotalebi 2010</td>
</tr>
<tr>
<td>Iranian native cheese</td>
<td>Lactobacillus brevis</td>
<td>Wound</td>
<td>F.Zahedi 2011</td>
</tr>
<tr>
<td>Probiotic yoghurt</td>
<td>-</td>
<td>Diabetes Type II</td>
<td>H.Ejtahed, 2013</td>
</tr>
</tbody>
</table>

3. Functional Dairy Foods

3.1. Probiotic Cheese

Cheese is one of the most successful probiotic dairy products that has high potential to carry bacteria. The number of probiotic bacteria in cheese can be more than 10 million and this microbial mass in cheese have more protective effects on probiotic bacteria in comparison to yogurt because of its chemical and physical properties such as low pH, high buffering capacity, high nutrients and high fat levels. Therefore, cheese has been one of the main sources of probiotic microorganisms. So far, many studies are done on design and production of different types of probiotic cheeses (Homayouni, 2014).

Many studies in Iran have been carried out on effect of various factors such as using a combination of probiotics and essential oils on the viability of probiotics. In a study, effects of the probiotic Lactobacillus casei and oregano on Staphylococcus aureus in white cheese have been investigated, according to the results, the best concentration of essential oils for inhibition of Staphylococcus aureus growth and production of desirable flavor properties was acquired when probiotic bacteria were added (Mahmoudi et al, 2010). In another similar study the effect of mint on the viability of Lactobacillus casei was assessed during cheese ripening. The results showed that mint extract has good effects on the viability of probiotic bacteria at the end of the process (Mahmoudi et al, 2013).

In another study the survival of Lactobacillus plantarum, Lactobacillus bulgaricus, Bifidobacterium animalis and angulatum at different stages of white cheese ripening was investigated. It was observed that the bacterial population at the end of cheese ripening period
was not less than $10^8$ (cfu/ml) which is more than the required amount to produce health promoting effects (Ehsani et al, 2011).

In many studies the ability of cheese and other dairy products as carriers of probiotic products were evaluated and are presented in Table 3.

**Table 3. Assess the functional probiotics in dairy products**

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Type of probiotic microorganisms</th>
<th>Initial inoculation dose</th>
<th>Survival at end of evaluation period</th>
<th>Researchs and date of publishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iranian white cheese</td>
<td><em>Lactobacillus rhamnosus</em></td>
<td>$10^6$</td>
<td>$10^7$</td>
<td>Mahmoudi 2012 (24)</td>
</tr>
<tr>
<td>Iranian white cheese</td>
<td><em>Bifidobacterium animalis</em></td>
<td>$10^6$</td>
<td>$10^8$</td>
<td>Mahmoudi 2013(24)</td>
</tr>
<tr>
<td>Ultrafiltration white cheese</td>
<td><em>Lactobacillus casei</em></td>
<td>$10^8$</td>
<td>$10^8$</td>
<td>Zomorodi 2009 (25)</td>
</tr>
<tr>
<td>Thyme yoghurt</td>
<td><em>Lactobacillus acidophilus</em></td>
<td>----</td>
<td>----</td>
<td>Marhamati Zade 2011 (26)</td>
</tr>
<tr>
<td>Fruity yoghurt</td>
<td><em>Lactobacillus fermentum</em></td>
<td>----</td>
<td>----</td>
<td>Shirzadi 2013 (27)</td>
</tr>
<tr>
<td>Yoghurt</td>
<td><em>Lactobacillus casei</em></td>
<td>$10^7$</td>
<td>$10^7$</td>
<td>Korbekandi 2009 (28)</td>
</tr>
<tr>
<td>Yoghurt</td>
<td><em>Lactobacillus casei</em></td>
<td>$10^6$</td>
<td>$10^6$</td>
<td>Mahmoudi 2012 (29)</td>
</tr>
<tr>
<td>Ice cream</td>
<td><em>Bifidobacterium bifidum</em> &lt;br&gt;<em>Lactobacillus acidophilus</em></td>
<td>----</td>
<td>----</td>
<td>Marhamatizadeh 2008 (30)</td>
</tr>
<tr>
<td>Ice cream</td>
<td><em>Lactobacillus casei</em> &lt;br&gt;<em>Bifidobacterium bifidum</em></td>
<td>$10^{11}$</td>
<td>$10^9$</td>
<td>Khosravi Zanjani 2014</td>
</tr>
</tbody>
</table>
Many studies have investigated the effects of probiotics on the growth of microorganisms. In a project, the effects of different concentration of combination of mint and $10^8$ to $10^9$ (cfu/ml) of *Lactobacillus casei* on the growth of pathogenic *Staphylococcus aureus* and *Listeria monocytogenes* during Iranian white cheese ripening were evaluated, results showed that the combination of mint extract and probiotic bacteria has synergistic effects in inhibiting the growth of pathogens (Ehsani and Mahmoudi, 2012).

3.2. Probiotic Yoghurt

Yoghurt is a fermentative dairy product which is made of milk and is produced by lactic acid bacteria. In production of yoghurt two starters are used including *Streptococcus thermophilus* and *Lactobacillus bulgaricus*; But none of the above can survive the digestive tract, thus aren't able to provide probiotic properties since they’re destroyed under acidic conditions. Acid-resistant species must be used. Yoghurt is produced by adding probiotic *Lactobacillus* and *Bifidobacterium* in the presence or the absence of starter. Health benefits of probiotic are intensified in the presence of starter and these properties are doubled while adding the probiotic bacteria (Homayouni, 2014). Many types of yoghurt with different probiotics have been produced around the world. Many studies have been done on the viability of probiotics during fermentation and storage. In a study, it was determined the best conditions which is affecting the parameter of temperature (incubation temperature and treatments temperature) on survival of probiotics containing *Lactobacillus acidophilus* and *Bifidobacterium lactis* in the environment (*Streptococcus thermophiles* and *Lactobacillus bulgaricus*) (Mortazavian, 2007). Same authors examined the storage temperature for cooling as the third parameter, the best time for the viability of both bacteria is to evaluate the initial probiotic bacteria and the average time for yoghurt preservation (Mortazavian, 2007). Probiotic yogurt in addition to their nutritional value, have an important role in fighting against the pathogens. Farahbakhsh has performed a research in this area in which antimicrobial effect of isolated probiotic from Rafsanjan local yoghurt on pathogens was investigated and due to this research *Lactobacillus plantarum* had the strongest antimicrobial effect (Farahbakhsh et al, 2012). In a similar research, antagonistic effect of lactic acid bacteria isolated from Golestan province yoghurt against 7 important species of digestive pathogens especially *Shigella dysentriae*, *Yersinia entrocolitica*, *Escherichia coli* and *Salmonella typhimorium* was studied which resulted in the fact that the highest inhibitory effect was about *Lactobacillus casei* and *Lactococcus lactis* and this inhibitory effect was more visible on *Yersinia entrocolitica* (Kianiand, 2006). Mahmudi investigated the survival of probiotics and other properties of probiotic yoghurt in the presence of different concentrations of mint extract with the count of $10^8$-$10^9$ (cfu/ml) *Lactobacillus casei* as the probiotic agent and they showed
that the amount of probiotic bacteria in combination with mint extract in probiotic yoghurt is higher than the minimal amount which is needed for observing the functional effects (Mahmoudi et al, 2014). Studies on different factors affecting the durability of probiotics resulted in the fact that this product can be presented as a functional probiotic product. Related studies are shown in Table 3.

3.3. Probiotic Dough

Dough is a beneficial dairy drink based on fermentative milk and one of the native drinks of Iran which is made by diluting yoghurt with adding water and salt, or by direct fermentation of produced milk and is very important due to its positive outcome on health. Using the technology and its functional effects, especially by adding probiotic bacteria can increase the consumers’ health (Hasheminya et al, 2011). Based on Iranian standard, probiotic dough by probiotic microorganisms is produced by using traditional yoghurt bacteria (Streptococcus thermophiles and Lactobacillus bulgaricus) or without them (Homayouni, 2014). Similarly, other probiotic products, survival of probiotic bacteria is investigated in this product by researchers. In this study, durability of probiotic microorganism in probiotic dough containing hydrophilic extract of Ziziphora tenuior is more than the essential amount needed for health and is recommended over the normal dough (Voosogh et al, 2009). Taheri showed that the tissue properties and bacterial survival in probiotic samples are acceptable in comparison to the control samples by studying the effect of Lactobacillus acidophilus on probiotic dough as a probiotic agent (Taheri et al, 2009).

3.4. Ice Cream

Ice cream is one of the safe, nutritional and frozen dairy products which is widely consumed around the world and since it causes a great deal of happiness, it has many fans. Considering its nutritional values, ice cream is a great source of essential amino acids of milk proteins, vitamins and minerals, and its components are easily digested and absorbed in the body (Abghari et al, 2008). Ice cream is produced normally or by fermentation. Probiotic microorganisms are added to the ice cream mixture in producing fermentative ice cream. Probiotic ice cream has the ability to survive in the human digestive system due to its neutral pH. The only problem is the ice cream aeration during the freezing process, which can affect the probiotics survival due to the existence of oxygen. Encapsulation method (micro-covering) in ice cream can solve this problem (Homayouni et al, 2008). In a research performed by Abqari, after adding Lactobacillus acidophilus, the survival rate of this bacteria in a type of fermentative ice cream was evaluated and it was observed that required amount \(10^8\) (cfu/ml) of bacterial mass
survived which is compatible with Probiotics product’s definition and can be considered as functional fermentative ice cream (Abghari et al, 2008). The results of studies on ice cream as a probiotic product are shown in table 3.

4. Suggestions for Increasing the Viability of Probiotic Bacteria

One of the main factors in producing functional foods containing probiotic bacteria is their shelf-life. In addition to their viability, the quantity is also of great importance because many probiotic bacteria are eliminated during food preservation and passing through the gastrointestinal tract. Many factors such as the type of the dairy product, existing air and low preservation temperature can affect the viability. Dairy products can help the survival of probiotic bacteria due to their pH buffering capacity. In addition, selected bacteria must be resistant to the acidic environment of the stomach and the food itself (such as yoghurt), should be resistant to the existence of oxygen, whereas most probiotics are anaerobic. There are numerous studies on probiotics viability. Direct protection of probiotics using micro-covering or micro-encapsulation methods can increase the probiotic viability. Micro-covering is the technology of packing small particles of solid, liquid or gas inside small mobile beads which can release their contents under specific conditions after a specific period of time. Materials used for probiotic capsulation are alginate and its derivatives, modified starch, mixture of xanthan and gelane, carrageenan and its derivatives, gelatin, chitosan and cellulose acetate. Different methods of micro-covering have been used for probiotic viability in Iran. Homayouni, observed that the probiotic bacterial viability in ice cream containing modified starch has increased after 180 days of preservation in -20° C. Khosravi observed increased survival of Lactobacillus casei and Bifidobacterium bifidum in ice cream were increased by using micro-covering with chitosan (Khosravi et al, 2014). High fat content, dry matter and pH are effective on probiotic viability in white Iranian cheese, which is demonstrated the ability of white Iranian cheese to hold the functional effect by encapsulation of Lactobacillus acidophilus with Calcium alginate and resistant starch (Mirzae et al, 2011).

Bi-phasic fermentation of yoghurt and fermentation of neutralized milk is another method to increase the probiotic viability, in which the amount of Lactobacillus acidophilus and Bifidobacterium langum are increased in the product. Another solution is to use genetic manipulations to produce the new varieties of probiotics. Primary microbe must be among normal microflora of human digestive system (Homayouni, 2008).

5. Conclusion
Functional foods are considered as health promoting foods aside their nutritional values for the consumers. Bright future for functional dairy products depends on the costumers’ satisfaction. Nowadays consumers look forward to using these functional products due their increasing knowledge about the beneficial effects of functional foods such as boosting the immune system, maintaining the normal microflora in the intestines, preventing gastrointestinal diseases and decrease in blood pressure and cholesterol level. Therefore, production of probiotic functional foods must be one of the main programs for manufacturers, regarding their increasing importance. Among all the probiotic functional products, dairy products are of great importance and they can be defined as carriers of probiotics bacteria. Many investigations are conducted on the production of functional foods and their positive outcome on public health and also suggesting solutions for increasing the viability and stability of probiotics during the process of production and preservation such as encapsulation of the bacterial mass. Also, evaluation of viability of probiotics in rough conditions of ice cream and cheese (low pH and freezing) is necessary. Further studies around the viability of probiotics microorganisms in other drinks is recommended.

References


Homayouni Rad A. Therapeutical Effects of Functional Probiotic, Prebiotic and Synbiotic Foods. First ed.; Tabriz University Of Medical Science: Tabriz, Iran, pp. 3-35


