I

Fundamentals of Functional Food Processing
1

Functional Foods, Nutraceuticals and Probiotics as Functional Food Components

Athapol Noomhorm, Anil Kumar Anal and Imran Ahmad
Food Engineering and Bioprocess Technology, Asian Institute of Technology, Pathum Thani, Thailand

1.1 Functional food

Eating food is no longer limited to just satisfying the appetite or providing basic nutrition. Consumers are driven by many issues related to health concerns, the negative effects of unhealthy food and a desire to have a healthier lifestyle, which have significantly changed modern attitudes towards food habits. Functional food can thus be summarized as the complete package of fundamental needs plus additional food ingredients that can play an important role in decreasing health risks and also improving health. The modern thirst for a healthy life through food was visualised 2500 years ago by Hippocrates in his famous doctrine ‘Let food be thy medicine and medicine be thy food’.

The term ‘functional food’ was first used by the Japanese in the mid 1980s. But in the past decade the market has expanded to the United States, northern Europe and central European countries (Menrad, 2003). Functional foods fall into two broad categories: plant origin and animal origin.

1.1.1 Functional components from plant origin

A plant-based diet can help to cure chronic diseases, especially cancer. A review conducted in 1992 showed that the risk of cancer among people consuming fruits and
vegetables is only half that of those consuming lesser amounts of these foods (Block et al., 1992). This proves that plant-based foods have some components that act against such lethal diseases. Such chemicals were classified by Steinmetz and Potter (1991) as phytochemicals. They identified a few such active plant components.

**Oats**  Oats is the most studied dietary supplement that is capable of lowering cholesterol as it contains β-glucan. The food with the highest amount of β-glucan was reported in oats (Wood and Beer, 1998; Manthey et al., 1999). Decreasing the level of low density cholesterol (LDL) can reduce the chances of coronary heart disease (CHD). Researchers have also shown that the hypocholesterolaemic effect of β-glucan can result in a 20–30% reduction of LDL-cholesterol, hence the chance of getting heart problems also decreases.

**Flax seed**  The use of flaxseed (Linum usitatissimum) as a suitable additive in functional food has become more widespread because of its potential health benefits, such as reducing the risk of heart disease (cardiovascular disease, CVD) (Bloedon and Szapary, 2004), diabetes (Haliga et al., 2009) and also in cancer. Phipps et al. (1993) have shown that the daily intake of 10 g of flaxseed can elicit several hormones which can reduce the risk of breast cancer. The health qualities of flaxseeds are mainly due to the presence of high omega-3 fatty acids; almost 57% of its oil is α-linoleic acid (ω-3). As well as this it contains a high amount of dietary fibre (both soluble and insoluble), proteins and antioxidants such as lignan. The presence of phenolic compounds in flaxseed such as lignan, secoisolariciresinol diglucoside (SDG) and ferulic acid gives flax seed its antioxidant properties (Kasote et al., 2011).

**Garlic**  This has been widely quoted as a plant with medicinal properties. The medicinal components of garlic have been shown to inhibit tumour genesis. It has also the potential to reduce the risk of cancer (Dorant et al., 1993) by protecting against carcinogenic agents. The main factor contributing to this are its sulfur constituents, which can suppress tumour formation in breast, colon, skin or lung cancer (Amagase and Milner, 1993). It has been reported that garlic has ten different types of natural sugars. Garlic can help reduce blood sugar levels (Sheela et al., 1995; Augusti and Sheela, 1996). It has been suggested that it is the best source of the nucleic acid adenosine, a building block of DNA and RNA (Blackwood and Fulder, 1987). Nearly 33 different sulfur compounds, enzymes, 17 amino acids and minerals have been reported in garlic (Newall et al., 1996).

Fibre is also added to food products to help maintain a healthy digestive tract, for example Yugao Bijin from Tokyo Tanabe Co. is a fibre enriched pasta, and Caluche is a snack product from Nissin Foods that is rich in fibre.

### 1.1.2 Functional components from animal resources

A vast number of components naturally present in animal sources are potentially beneficial to health.

**Fish oil**  Omega-3 fatty acids are a major component of polyunsaturated fatty acids (PUFA) from fish oil. Omega-3 has many health benefits. It has been found that a
1.2 NUTRACEUTICALS

daily intake of docosahexaenoic acid (DHA) up to 0.5–0.7 g decreases the chances of CHD (Kris-Etherton, Harris and Appel, 2002). Omega-3 supplements can be taken if our everyday food is deficient in omega-3. Omega-3 FA also has beneficial effects in rheumatoid arthritis, inflammatory diseases such as asthma (Reisman et al. (2006), cystic fibrosis and bowel diseases. A high DHA content in the body can help decrease the risk of Alzheimer’s disease.

Dairy products Dairy products are undoubtedly a good source of functional components, one major ingredient being calcium, a nutrient required to prevent osteoporosis and possibly also colon cancer. Milk has potential probiotic components which are a good source of food for the beneficial microbial flora inside the gut. The term probiotics was defined by Gibson and Roberfroid (1995) as ‘non-digestible food that beneficially affect the host by selectively stimulating the growth of gut microbial flora’. These may include different dietary fibres, starches, sugars that do not get absorbed directly, sugar alcohols and oligosaccharides (Gibson et al., 1996).

1.1.3 Examples of functional foods widely popular in the market

The development of drinks as functional foods has grown widely in and is an easy way to satisfy consumer demand for these foods. Most of these drinks contain dissolved fibres, minerals and vitamins. For example, Pocari Sweet Stevia from Ootsuka, is a sport drink that contains a glucose substitute sweetener (a glycoside from the Stevia plant); and Fibi, a soft drink from Coca-Cola, contains a high amount of fibre, is mainly focused on improving the digestive system.

The first probiotic product launched in market was Yakult from Yakult Honsha, a probiotic yoghurt drink, which contains Lactobacillus and Bifidobacterium. The health benefits related to these probiotic products are increased digestive control, inhibition of pathogenic flora, immune power stimulation, reduced risk of tumour genesis, production of vitamins (especially B vitamins) and generation of bacteriocins (Potter, 1990; Sanders et al., 1991). For example, Yoplait’s low-fat yoghurt Yo-Plus, with probiotic bacteria (Bifidobacterium lactis) mixed with probiotic (inulin) provides a perfect symbiotic combination, and a live active natural cheese product launched by Kraft contains probiotic strains Lactobacillus lactis for better digestive health.

1.2 Nutraceuticals

Nutraceuticals are a type of dietary supplement that delivers a concentrated form of a biologically active component from a food, presented in a non-food matrix, to enhance health in dosages that exceed those that could be obtained from regular food (Zeisel, 1999). A nutraceutical is a product isolated or purified from foods that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic diseases (DeFelice, 1992).

The term ‘nutraceuticals’ was first coined by the Foundation for the Innovation in Medicine.
The actual boundary between functional food and nutraceuticals is not clear. It can be explained with the help of a simple example: if a phytochemical extract with medicinal value is included in a food product, i.e. 200 mg of the extract needs to be incorporated into 1 litre of orange juice, we get a new functional food. The same 200 mg extract can be marketed in the form of a capsule as a new nutraceutical.

A major source of nutraceuticals is omega-3 fatty acids (PUFA) from fish oils. These contain high amounts of eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA), categories of fatty acids that have a protective effect against cardiovascular disease and inflammatory disease and also affect other chronic diseases. Fish oil mainly prohibits the end-organ effects of tumour-derived lipolytic and proteolytic factors, influencing the action of many receptors as well as enzymes which function during cellular signalling.

The non-essential amino acid arginine has received much attention as it has efficient immune stimulation properties. Arginine was also effective in some clinical conditions in improving the cellular immune system, increasing phagocytosis and the proper maintenance of T cells. Arginine enhances the suppressed immune response of individuals that have injury diseases, surgical trauma or malnutrition (Kirk and Barbul, 1990; Evoy et al., 1998).

Table 1.1 lists functional components extracts and the effects of applying them in medicinal form, so that their consumption becomes easier.

<table>
<thead>
<tr>
<th>Supplement</th>
<th>Composition</th>
<th>Dose (per day) and assay period</th>
<th>Subjects</th>
<th>Effect</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grape seed extract</td>
<td>Oligomeric procyanidins</td>
<td>200–300 mg/day; 1 year</td>
<td>3 patients with chronic pancreatitis</td>
<td>Reduction of chronic pancreatitis, vomiting and pain</td>
<td>Banerjee and Bagchi, 2011</td>
</tr>
<tr>
<td>Mixture of grape, bilberry and cranberry extract (capsule)</td>
<td>Oligomeric procyanidin</td>
<td>320 mg/day</td>
<td>13 menopausal women</td>
<td>Reduction of fluid retention</td>
<td>Christie et al., 2004</td>
</tr>
<tr>
<td>Soya supplement</td>
<td>Isoflavones</td>
<td>60 mg (3 months)</td>
<td>33 postmenopausal women</td>
<td>Significant cognitive improvement</td>
<td>Duffy et al., 2003</td>
</tr>
<tr>
<td>Red clover supplement</td>
<td>Isoflavones</td>
<td>80 mg (90 days)</td>
<td>60 postmenopausal women</td>
<td>Decrease of menopausal symptoms. Positive effect on vaginal cytology and triglycerides</td>
<td>Hidalgo et al., 2005</td>
</tr>
<tr>
<td>Red clover extract capsule</td>
<td>Isoflavones</td>
<td>100 mg (6 months)</td>
<td>30 postmenopausal women</td>
<td>Hypoglycaemic</td>
<td>Cheng et al., 2004</td>
</tr>
</tbody>
</table>

1.3 Functional food market

Research indicates that there is an estimated global market for functional foods of US$33 billion (Hilliam, 2000c). Functional foods account for 2% of the US food market. Another competing market is Japan, which focuses mainly on health claims. The concept of ‘functional foods’ was first introduced by Japan in 1984 (Hosoya, 1998), and between 1988 and 1998 (Heasman and Mellentin, 2001) the number of functional food products reached nearly 1700, with an estimated turnover of US$14 billion in 1999 (Hilliam, 2000). Within the European market, functional foods have a monetary value of US$4–8 billion (Hilliam, 2000). Figure 1.1 illustrates the main categories of functional foods in Germany.

Functional benefits may provide added value to consumers but cannot outweigh the sensory properties of foods. By purchasing functional foods in general consumers may achieve a modern and positive impression of themselves. These products provide consumers with an alternative way to achieve a healthy lifestyle that differs from conventional healthy diets defined by nutrition experts. In general, the attitude both to functional foods and to their consumers is positive, so such a concept represents a sustainable trend in a multi-niche market (see Table 1.2).

1.4 Probiotics

The market of functional food is growing through the continuous development of technology. Functional food with added probiotic has gained the attention of many researchers. The use of probiotics in combination with prebiotic has been very effective against several chronic diseases. Probiotics have been defined as the ingested live
bacteria which are responsible for providing a healthy life. The gut microflora plays an important role in maintaining stable health and disease protection (Steer et al., 2000). The metabolic activity of the gut flora provides up to 50% of the energy required by the host body’s gut wall through the fermentation of carbohydrates into organic acids (Figure 1.2).

### 1.4.1 Role of probiotics

Probiotics and prebiotics provide an alternate source for the management of different intestinal disorders. It was demonstrated that the bacterial count in the faecal matter of children is more than in adults, with high amounts of *Lactobacillus* and *Bifidobacterium*. Disorders such as gastroenteritis unbalance the biochemical environment of the gut, but the intake of probiotic functional food can stabilize the colonic microflora and also help in their maintenance against the adverse effect of antibiotics. Figure 1.3 shows a recent study of the probiotic mechanism on health enhancement.

The major contributions associated with the work of probiotics on human health are proper colonic function and increased metabolism. They are also responsible for the enhancing the expression of short chain fatty acids, the increase in faecal weight, decreased colon pH, reduced release of nitrogenous material from the body
1.5 Prebiotics

Prebiotics are foods that are beneficial but cannot be digested by the host’s metabolism and can help in the growth and other activities of beneficial bacteria residing in the human gut. This indirectly improves the host’s health (Gibson and Roberfroid, 1995).

Widely used prebiotics are inulin, fructo-oligosaccharide (FOS), lactulose and galacto-oligosaccharides (GOS). They improve the composition of the gut microbiota to give enhanced numbers of beneficial bacteria. Though there is no fixed recommendation for the daily intake of prebiotics, one study has shown that 4–20 g/day gives good results (K.M. Tuohy et al., unpublished data). Research data on inulin and reductive enzymes (Bournet, Brouns, Tashiro and Duvillier, 2002; Forchielli and Walker, 2005; Qiang, YongLie and QianBing, 2009). Table 1.3 shows some contributions of prebiotics.

![Diagram of prebiotics and probiotics effects](image-url)
3. Competition for nutrients

1. Pathogens exclusion

2. Immune simulation

4. Antimicrobial substances and direct antagonism

5. Barrier function

6. Reduction of inflammation

Figure 1.3 Some probiotic mechanisms that induce several beneficial host responses. Most effects consist of (1) Exclusion and competing with pathogen to epithelial cells adhesion, (2) innate immune stimulation, (3) competition for nutrients and prebiotic products, (4) production of antimicrobial substances and thereby pathogen antagonism, (5) protection of intestinal barrier integrity and (6) regulation of anti-inflammatory cytokine and inhibition of pro-inflammatory cytokine production. IEC, intestinal epithelium cells; DC, dendritic cell; IL, interleukin; M, intestinal M cell. Source: Saad et al., 2013. Reproduced with permission from Elsevier. For colour details, see the colour plates section

or FOS intake suggest that 4 g/day is needed to increase *Bifidobacteria* (Roberfroid et al., 1995).

### 1.5.1 Sources of prebiotic

Prebiotics are mainly obtained from plant sources and algae polysaccharides. The extraction is carried out either by a chemical process which hydrolys the polysaccharides or by an enzymatic process of synthesis from disaccharides (Nugent, 2000; Mussamatto and Mancilha, 2007). The main prebiotics in use are FOS, GOS, isomalt-oligosaccharides (IMO) and xylo-oligosaccharides (XOS). Primarily oligosaccharides, such as soy oligosaccharides (SOS), GOS and XOS are also marketed in Japan (Ouwehand, 2007).

Currently, inulin is the major prebiotic made. It is produced by chemical synthesis using transglycosylation, which produces polysaccharides from monosaccharides and disaccharides. Figure 1.4 shows a brief description of the process of transglycosylation (Delattre et al., 2005; Barreteau et al., 2006).
1.5 PREBIOTICS

Table 1.3 The contributions of probiotics

<table>
<thead>
<tr>
<th>Disease type</th>
<th>Contribution by the probiotics</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intestinal flora</td>
<td>Inhibits the growth of pathogenic species like S. dysenteriae, S. typhosa and E. coli and this results in reduced diarrhoea and vomiting</td>
<td>Asahara et al., 2001</td>
</tr>
<tr>
<td>Lactose intolerance</td>
<td>Lactose supplement could help in the digestion of lactose by helping in its fermentation.</td>
<td>Jiang and Savaiano, 1997</td>
</tr>
<tr>
<td>Immuno-modulatory effects of probiotics</td>
<td>Administrating probiotics has proven the activity on Payer’s patches, NK cell activity, enhance of IgA production in intestine, development of GALT (gut-associated lymphoid tissue)</td>
<td>Palma et al., 2006; Hosono et al., 2003; Hoentjen et al., 2005; Nakamura et al., 2004; Pierre et al., 1997</td>
</tr>
<tr>
<td>Preventing cancer</td>
<td>Recent research showed that butyric acid production by the fermentation of probiotics plays a lead role in cancer prevention. This acid helps in the chemoprevention of carcinogenesis, and also against colon cancer by the promotion of differentiation of cell (not anti-inflammatory effect on colon cancer cells)</td>
<td>Femia et al., 2002; Pool-Zobel, 2005; Munjal et al., 2009; Verghese et al., 2002; Kim et al., 1982</td>
</tr>
<tr>
<td>Lipid metabolism</td>
<td>Probiotics have been proven to show a positive effect on the hepatic lipid metabolism. Experiment of RTS has shown a decrease in cholesterol and triglycerides levels by 15% and 50% respectively due to the suppression of lipogenic enzyme activity</td>
<td>Delzenne et al., 2002; Fiordaliso et al., 1995; Delzenne and Kok, 2001; Williams and Jackson, 2002</td>
</tr>
</tbody>
</table>

(a) Donor

(b) Nucleotide-sugar donor

Figure 1.4 Synthesis of oligosaccharides by glycosylation using (a) a chemical process and (b) an enzymatic process with glycosyltransferases. Source: Saad et al., 2013. Reproduced with permission from Elsevier
<table>
<thead>
<tr>
<th>Product</th>
<th>Probiotic microorganisms</th>
<th>Substrates</th>
<th>Published references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adai</td>
<td>LAB L. plantarum, L. brevis, L. fermentum, Leuc. mesenteroides</td>
<td>Cereal, legume</td>
<td>Farnworth, 2005</td>
</tr>
<tr>
<td>Agbelima</td>
<td>Lb. plantarum, Lb. brevis, L. rhamnosus, L. fermentum, Leuc. mesenteroides subsp. dextranum</td>
<td>Cassava</td>
<td>Amoa-Awua et al., 2005</td>
</tr>
<tr>
<td>Atole</td>
<td>LAB L. plantarum, Lb. brevis, L. rhamnosus, L. fermentum, Leuc. mesenteroides subsp. dextranum</td>
<td>Pearli millet</td>
<td>Escamilla-Hurtado et al., 1993</td>
</tr>
<tr>
<td>Ben-saalga</td>
<td>LAB L. brevis, Lb. fermentum, Leuc. mesenteroides</td>
<td>Cereals</td>
<td>Tou et al., 2006</td>
</tr>
<tr>
<td>Boza</td>
<td>Lb. plantarum, Lb. brevis, L. rhamnosus, L. fermentum, Leuc. mesenteroides subsp. dextranum</td>
<td>Rice and Bengal gram</td>
<td>Hancioglu and Karapinar, 1997; Moncheva et al., 2003; Botes et al., 2007; Todorov et al., 2008</td>
</tr>
<tr>
<td>Dosa</td>
<td>Leuc. mesenteroides, Lb. fermentum, Sacch. cerevisiae</td>
<td>Cereal, legume</td>
<td>Soni et al., 1986; Agrawal et al., 2000; Aidoo et al., 2006; Balasubramanian and Viswanathan, 2007</td>
</tr>
<tr>
<td>Idili</td>
<td>Leuc. mesenteroides, LAB, yeast</td>
<td>Maize</td>
<td>Farnworth, 2005</td>
</tr>
<tr>
<td>Ilambazi lokubilisa</td>
<td>LAB</td>
<td>Wheat, soybeans</td>
<td>Roling et al., 1999</td>
</tr>
<tr>
<td>Kecap</td>
<td>LAB</td>
<td>Maize</td>
<td>Olsen et al., 1995; Olasupo et al., 1997</td>
</tr>
<tr>
<td>Kenkey</td>
<td>Lb. casei, Lb. lactis, L. plantarum, L. brevis, Lb. acidophilus, Lb. fermentum, L. casei, yeast</td>
<td>Wheat, soybeans</td>
<td>Roling et al., 1999</td>
</tr>
<tr>
<td>Kimchi</td>
<td>Lb. plantarum, Lb. curvatus, Lb. brevis, Lb. sake, Leuc. mesenteroides</td>
<td>Vegetables</td>
<td>Chin et al., 2006; Lee et al., 2006; Lee and Lee 2006</td>
</tr>
<tr>
<td>Kishk</td>
<td>LAB</td>
<td>Cereal and milk</td>
<td>Tamime and McNulty, 1999</td>
</tr>
<tr>
<td>Kisa</td>
<td>Lactobacillus sp., L. brevis</td>
<td>Sorghum</td>
<td>Mohammed et al., 1991</td>
</tr>
<tr>
<td>Koko</td>
<td>Lb. fermentum, Lb. salivarius</td>
<td>Millet</td>
<td>Lei and Jacobsen, 2004</td>
</tr>
<tr>
<td>Mahewu</td>
<td>Lb. bulgaricus, Lb. brevis</td>
<td>Maize</td>
<td>McMaster et al., 2005</td>
</tr>
<tr>
<td>Mawe</td>
<td>Lb. fermentum, Lb. brevis, Lb. salivarius, Sacch. cerevisiae</td>
<td>Maize</td>
<td>Hounhouigan et al., 1999</td>
</tr>
<tr>
<td>Ngari</td>
<td>Lactococcus lactis subsp. cremoris, Lactococcus plantarum, Enterococcus faecium, Lb. fructosus, Lb. amylophilus, Lb. corynformis subsp. torquens, and L. plantarum</td>
<td>Fish</td>
<td>Thapa et al., 2004</td>
</tr>
<tr>
<td>Ogi</td>
<td>Lb. plantarum, L. fermentum, Leuc. mesenteroides, and Sacch. cerevisiae</td>
<td>Maize</td>
<td>Odunfa and Adeyele, 1985; Adeyemi, 1993; Ijabadeniyi, 2007; Omeme et al., 2007</td>
</tr>
<tr>
<td>Sauerkraut</td>
<td>Leuc. mesenteroides, Lactococcus lactis, LAB</td>
<td>Cabbage</td>
<td>Harris et al., 1992; Lu et al., 2003; Johanningsmeier et al., 2005</td>
</tr>
<tr>
<td>Som-fug</td>
<td>LAB</td>
<td>Fish</td>
<td>Riebroy et al., 2007</td>
</tr>
<tr>
<td>Tarhana</td>
<td>Streptococcus thermophilus, Lb. bulgaricus, L. plantarum</td>
<td>Parboiled wheat meal and yogurt</td>
<td>Blandino et al., 2003; Patel et al., 2004; Erbas et al., 2006; Ozdemir et al., 2007</td>
</tr>
<tr>
<td>Tempeh</td>
<td>LAB, Lb. plantarum</td>
<td>Soybean</td>
<td>Ashenafi and Busse, 1991; Feng et al., 2005</td>
</tr>
<tr>
<td>Uji</td>
<td>LAB</td>
<td>Maize, sorghum cassava, finger millet</td>
<td>Onyango et al., 2003</td>
</tr>
</tbody>
</table>

1.5.2 Functional probiotic products

Traditional probiotic products  The reason for opting for probiotic food can best be explained as an easy way to maintain daily health. Eating junk foods, drinking chlorinated water, work stress and irregular diet can have a serious impact on the gastrointestinal tract by destroying the beneficial microbial flora. So the ready availability of probiotics in the market helps resolve the problem to a great extent.

Kefir is a traditional milk product containing lactic acid bacteria and yeasts, which have a symbiotic relationship. Fermented milk products (kefir, yoghurt or sour milk) have higher nutritional values and a high nitrogen content compared with milk.

Kombucha is a fermented tea product and a symbiotic culture of yeast and bacteria. It is a traditional product that has been used for centuries and has recently gained attention globally, especially in the United States.

Another traditional Japanese food with probiotics is made from soybeans — a fermented product of fungi called koji. Table 1.4 shows examples of potential probiotic traditional fermented foods.

Present day commercial products  Products available in market with combined probiotics and prebiotics are now widely accepted. In 2008, Beyaz Peynir cheese from Turkey, a traditional cheese with nutritional value, was available with the addition of Lactobacillus plantarum.

The very first product marketed as a probiotic rather than a traditional product was Yakult by Yakult Honsha, Japan. Other commercial probiotic products available in market are shown in Table 1.5.

1.6 Probiotic market

The probiotic market is a growing industry, with lactic acid bacterial drinks accounting for 10% of the market. As health awareness increases, health-vigilant consumers are increasingly choosing probiotic functional products and as a result the market is growing at a rate of 5–30% (percentage varies with the country and product types).

The distribution of the probiotics application is shown in Figure 1.5.

The probiotic market was estimated to be around US$24.33 billion in 2011. A survey by marketsandmarkets.com (2013) says that more than 500 probiotic food and

<table>
<thead>
<tr>
<th>Table 1.5</th>
<th>Probiotic foods in present market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand name</td>
<td>Food type</td>
</tr>
<tr>
<td>Yakult Honsha Co., Ltd.</td>
<td>Dairy beverage</td>
</tr>
<tr>
<td>Attune Food</td>
<td>Chocolate bar</td>
</tr>
<tr>
<td>Kevita</td>
<td>Probiotic non-diary drinks</td>
</tr>
<tr>
<td>Amul</td>
<td>Prolife (yoghurt and ice-cream)</td>
</tr>
<tr>
<td>GoodBelly</td>
<td>Probiotic fruit juice</td>
</tr>
<tr>
<td>Life way</td>
<td>Kefir drink</td>
</tr>
<tr>
<td>Ombar</td>
<td>Probiotic chocolates</td>
</tr>
<tr>
<td>Dannon</td>
<td>An Active dairy drink</td>
</tr>
</tbody>
</table>
drink products have been marketed in past 10 years. Different categories of products have gained varying levels of success. The most accepted product was probiotic chocolate. The highest sales were from the food and beverage section, which makes up 85% of the total probiotic products. Among all the probiotic products, 80% of probiotic sales in 2011 came from dairy products.

According to the report published by ‘Markets and Markets’ (http://www.marketsandmarkets.com), ‘probiotic market was valued at $24.23 billion in 2011 and is expected to grow at a CAGR [compound annual growth rate] of 6.8% from 2012 to 2017’.

The growing health consciousness and awareness of food safety are promoting further success in an already lucrative probiotic market.

References

REFERENCES


REFERENCES


REFERENCES


