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RESEARCH ARTICLE

PROBIOTICS – AN OVERVIEW

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ABSTRACT

The current review work deals about the details of microbes as a probiotic and its beneficial effects for different applications. Probiotics are microorganisms that have health promoting influence in the body. They must be able to withstand the acid in the stomach and bile salts to perform the natural functions in the body. Probiotics have wide range of benefits including boosting the immune system, combating infections, allergies and regulating the digestive system as well as relieving lactose intolerance. Probiotics are classified as food supplements and suited to be used in yogurts, curds and their drinks. Fruit and vegetable juices have also been found to be suitable for the incorporation of probiotics as they promote health by way of providing vitamins and minerals which make it a complementary and an alternative to medicines. The acceptance of a probiotic foods India is growing slowly however, it has a good potential for growth as a health food.

INTRODUCTION

What are Probiotics

Probiotic is a mixed culture of live organisms which is a live food or feed supplement and which appears to beneficially affect animals and humans by improving intestinal microbial balance (Fuller 1989). They are "good bacteria" that help to maintain healthy balance of bacteria in the digestive system. Probiotic foods have beneficial effects on the intestinal flora of the host and have an important role in the prevention of food borne diseases caused by many pathogenic microorganisms. Therefore, use of probiotic bacteria in foods is increasing in the present global food chain. Over a past decade there has been increased interest in bacterial food supplements which are now referred as probiotics (Diwani, 2004). Probiotics is a healthy way for life, the origin of the term probiotics was credited by Werner kolath in 1954. The Greek meaning of the term probiotics is "For Life" and it is opposite to antibiotics which mean "Against Life" (Guarner *et al.,* 2005). In other words, Probiotic, literally meaning "For life",are microorganisms proven to exert health promoting influence in human and animal (Marteau *et al.,* 1995). The majority of the papers suggest that the potential benefits following the consumption of fermented diary product containing viable Lactic acid bacteria (Gilli and Guarner, 2004) is primarily attributable to the favorable alteration in GI micro *eco*logy. In the recent past, there is increasing consumer awareness throughout the globe on the potential influence of various foods stuff on health benefits. Consumers are becoming more and more health conscious now than ever before. They expect the food products to be healthy, tasty and functional. This has triggered the food Industry to look for opportunities to improve the existing products as well as developing the new products which can contribute not only to a healthy balance diet but also good in taste and appearance. Application of scientific and engineering principles of processing of materials by microorganism is to provide goods and services to common human being. Microbiologist identified micro flora in the gastrointestinal (GI) tract of the healthy individual that differed from those found in diseased individual. These beneficial micro flora found in the GI tract were termed as Prebiotics.

Health-promoting effects attributed to probiotics are becoming aware among the today's modern consumers. The potential roles of probiotics as natural barriers to pathogens associated with intestinal disease are scientifically well documented. At the same time, the effects on human health like alleviation of symptoms of lactose intolerance, antidiarrheal effects, reduced risks of some cancers, improved intestinal and urogenital health, enhanced immune functioning, moderation of allergic reactions, inhibition of Helicobacter pylori stomach infections, possible cholesterol-lowering effects, mild antihypertensive effects, effects on alcohol-induced liver disease are some of the present talk about the benefit of probiotics to our present life (Sanders, 1999). Among the probiotics, the potential of probiotic lactic acid bacteria are well studied and documented (Horn, 1999). The functional properties of Probiotic bacteria are varied depending on the species. Some bacteria have a role

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in maintaining gastrointestinal tract health e.g. *Lactobacilli* and *Bifidobacteria spp.* (Short and Merryfield, 1999). There are two main types of probiotic, namely *Lactobacillus sp.,* and *Bifidobacteria*, with has around seven different alternatives. They perform natural functions with in the gut, which are reported as to protect the body against harmful bacteria; to prevent the growth of harmful bacteria; to help with gut problems, for example, constipation and wind; to help maintain cholesterol levels; to produced some 'B' vitamins, folic acid and some amino acids; to help the body absorb vitamins B1; and to produce anti oxidants and bacteriocins (Hose and sozzi, 1991). Probiotic are most commonly suited to use in Yoghurts, Yoghurt drinks, capsules or tablets. However, lactic acid combinations with fruit juice offer one of the best incremental growth opportunities for beverages. Fruit juices are particularly good source of vitamin and minerals but combination with probiotic would make complimentary and alternative to medicines (Fragoso and Fernandez, 2000).

Types of Micro Organisms as Probiotics

For an organism to be considered to be used as Probiotic, it must be able to withstand stomach acid and bile salts, further be able to adhere to the surface of the gastro intestinal tract to produce useful enzyme and metabolites (Hose and sozzi, 1991). There are two main types of probiotic, namely *Lactobacillus sp.,* and *Bifidobacteria*, with has around seven different alternatives. They perform natural functions with in the gut. Probiotics can be bacteria, moulds, yeast. But most probiotics are bacteria. Among bacteria, lactic acid bacteria are more popular. *Lactobacillus acidophilus*, *L. casei*, *L. lactis*, *L. helviticus*, *L. salivarius*, *L. plantrum*, *L. bulgaricus*, *L. rhamnosus*, *L. johnsonii*, *L. reuteri*, *L. fermentum*, *L. del brueckii*, *Streptococcus thermophilus*, *Enterococcus faecium*, *E. faecalis*, *Bifidobacterium bifidum*, *B. breve*, *B. longum* and *Saccharomyces boulardii* are commonly used bacterial probiotics. A probiotic may be made out of a single bacterial strain or it may be a consortium as well. Probiotics can be in powder form, liquid form, gel, paste, granules or available in the form of capsules, sachets, etc. Typical Yoghurt types are *Streptococcus salivarius* sub sp. *Thermophilus* and *Lactobacillus delbrueckii* sub sp. *Bulgaricus* (Bhattacharya and Ray 2002).

Probiotic organisms are mainly derived from normal inhabitants of the gut, probiotic foods e.g. yoghurt, milk, cheese and butter which attributes of good probiotic organisms such as *Lactobacillus casei*, *L. acidophilus*, *Bifidobacterium bifidus*, *B. longum*, *Streptococcus durans* and *Pediococcus acidilactici* (Hull *et al.,* 1992).

Characteristics of Lab

Lactic acid bacteria are used in food industry for several reasons; their growth lowers both the carbohydrate contents of the food that they ferment and pH due to lactic acid production. It is this acidification process of the microbe that has inhibits the growth of the microbe on its own. The pH may drop to as low as 4.0, low enough to inhibit the growth of most other microorganism including the most common human pathogen thus allowing these foods prolong shelf life (Jain and Brahmabhutt, 2005). These are come of the most common aspects of the probiotic microbes.

- They are relatively heat stable
- Plasmid – borne/ chromosomal mediated.
- They are sensitive to proteolytic enzymes.
- Relatively acid - tolerant.
- Relatively cold tolerant.
- Narrow inhibitory spectrum of activity centered about homologous (closely related) species.
- The presence of essential, biologically active protein moiety is required for their activity.
- Bactericidal/Bacteriostatic.
- They are having pH stability.
- Susceptibility to denaturation by enzymes.
- They are stable during storage.
- They can be extracted with organic solvent

Health Benefits of Probiotics

Probiotics have a wide range of benefits, including boosting the immune system to help combat infections, allergies, and exposure to toxins, and also regulating the digestive system, relieving lactose intolerance, and even IBS. Each bacterial strain has unique strengths, so most probiotic supplements include a variety of strains for maximum benefits. For health benefits, probiotic bacteria must be viable and available at a high concentration, typically above 106 cfu/ml or per gram of product (Saarela, 2002). Generally, probiotic supplements emphasize one of the types of probiotics. Depending on your own needs, one might be more beneficial to you than another, so the health benefits unique to these main types are listed below (Wang et al, 2008). Probiotics have been extensively studied under *in vitro* and *in vivo* conditions by Manisha *et al.,* (2001). The health effects attributed to the use of probiotics are numerous.

Some of the commercially used probiotics *Lactobacilli* and *Bifidobacteria*

S. No	Strain	Country	Company
1	*Lactobacillus rhamnosus GG*	Finland	Valio Dairy, Helsinki
2	*Lactobacillus johnsonii Lal*	Switzerland	Nestle, Lausanne
3	*Lactobacillus casei Shirota*	Japan	Yakult, Tokyo
4	*Lactobacillus acidophilus*	USA	Rhodia, Madison
5	*Lactobacillus casei DN 014001*	France	Danone
6	*Lactobacillus delbruekii*	Japan	Meiji Milk Products, Tokyo
7	*Saccharomyces boulardii*	USA	Biocodex, Seattle
8	*Bifidobacterium longum BB536*	Japan	Morinaga Milk Industry

There is some evidence of health effects through the use of probiotics for the following (Schrezenmeir and Vrese, 2002). Maintenance of normal intestinal flora by competitive inhibition of pathogenic microbes for adhesion receptors on the gut epithelium and also competing for nutrients. These also cause inhibition of pathogenic organisms by producing antibacterial substances called bacteriocins, thus reducing the GIT diseases. These provide protection against ulcers caused by Helicobactor pylori by preventing adhesion of this

pathogen. Various probiotic spp.have shown promise in the treatment of ulcerative colitis and Crohn's disease (Rafter 1995). Enhanceement of immune system by increasing number of Ig A producing plasma cells and also increasing number of T-lymphocytes and natural killer cells, thus act as classic immunomodulators. Regulation of lactose intolerance by directly converting lactose into lactic acid and reducing intestinal transit time. This enhances lactose digestion .Pricipal bacteria involved are Lactobacilli and Bifidobacteria. Reduction of serum cholesterol level by deconjugation of bile Lactobacilli, which interrupts the entero-hepatic circulation of bile salts. Lactobacilli also inhibit hydroxyl methyl glutarate co-A reductase, the rate limiting enzyme in cholesterol synthesis and thus prevent and increase in LDL level.

Anti carcinogenic activity of probiotics is depicted by its detoxification of gut toxins by binding with hetero cyclic amines which are carcinogenic substances found in cooked meat. These also decrease activity of enzymes like beta-glucorinidase which can regenerate carcinogens in the digestive system. They also cause inhibition of tumour cells and increase defense mechanism of the body by stimulating immune system (De Simone, 1993). Probiotics cause lowering of blood pressure by producing ACE inhibitor like peptides during fermentation. Probiotics reduce inflammation by by preventing hyper sensitive responses and also by regulation of cytokine function. The Lactobacillus and Bifidibacterium longum has been successfully used to reduce the after effects of antibiotic therapy (Zocco *et al.,* 2000). Studies have shown that the absence or depletion of Lactobacillus in vagina is one of the main reasons for BV infections and these results in significantly increased risk of HIV as well as Gonnorhoea, Chlamydia and Herpes simplex viral infections (Ringdahi, 2000).

Probiotics are gaining importance because of the innumerable benefits, e.g. treating lactose intolerance, hypercholesterol problem, cardiac diseases and managing cardiac problems like atherosclerosis and arteriosclerosis. With the current focus on disease prevention and the quest for optimal health at all ages, the probiotics market potential is enormous. Health professionals are in an ideal position to help and guide their clients toward appropriate prophylactic and therapeutic uses of probiotics that deliver the desired beneficial health effects. Clinical symptoms that have been reportedly treated or have the potential to be treated with probiotics include diarrhoea, gastroenteritis, irritable bowel syndrome, and inflammatory bowel disease (IBD; Crohn's disease and ulcerative colitis), cancer, depressed immune function, inadequate lactase digestion, infant allergies, failure-to-thrive, hyperlipidaemia, hepatic diseases, Helicobacter pylori infections, and others. The use of probiotics should be further investigated for its possible benefits and its side-effects if any (Benchimol and Mack 2004; Brown and Valiere 2004).

Preventative and Therapeutic Effects against Diarrhea

The well-known uses of probiotics is for diarrhoeal diseases prevention and management of acute viral and bacterial diarrhoea as well as the control of antibiotic associated diarrhoea are areas of significant potential benefit. A number of specific strains, including *Lactobacillus GG, Lactobacillus reuteri, Sacc. boulardii, Bifidobacteria spp.,* and others, have been shown to have significant benefit for diarrhoea (Marteau *et al.,* 2001; Benchimol and Mack 2004), travellers' diarrhea and diarrhoea disease in young children caused by rotaviruses (Vanderhoof 2000). The probiotic species that show the most promise in treating diarrhoea diseases in children include *Lactobacillus spp., L. reuteri, Lactobacillus casei, Sacc. boulardii, Bifidobacterium bifidum and Strep. thermophilus* (Tomas *et al.,* 2004). Lactic acid bacteria are known to release various enzymes into the intestinal lumen that exert synergistic effects on digestion, alleviating symptoms of intestinal malabsorption. In the paediatric population, probiotics appear to benefit viral diarrhoea, possibly by increasing secretary IgA and decreasing viral shedding, suggesting an immunological mechanism. Probiotics can prevent or ameliorate diarrhoea through their effects on the immune system. Moreover, probiotics might prevent infection because they compete with pathogenic viruses or bacteria for binding sites on epithelial cells. Probiotics might also inhibit the growth of pathogenic bacteria by producing bacteriocins such as nisin (del Miraglia and De Luca 2004).

Alleviation of Lactose Intolerance

Lactic acid of the yoghurt alleviates the symptoms of lactose intolerance in lactase-deficient individuals. The beneficial effect appears to be a consequence of the lactic acid bacteria in fermented milk increasing lactase activity in the small intestine (Marteau *et al.,*2001). Hepatic disease Hepatic encephalopathy (HE) is a liver disease and its effects can be life threatening. The exact pathogenesis of HE still remains unknown. The probiotics *Strep. thermophilus, Bifidobacteria, L. acidophilus, Lactobacillus plantarum, L. casei, L. delbrueckii bulgaricus,* and *E. faecum* containing therapeutic effect have multiple mechanisms of action that could disrupt the pathogenesis of HE and may make them superior to conventional treatment and lower portal pressure with a reduction in the risk of bleeding (Cunningham-Rundles *et al.,* 2000; Solga 2003).

Inflammation / Arthritis

Probiotic supplementation has both direct and indirect effects. Probiotics exhibit direct effects locally in the GI tract, including modulation of resident bacterial colonies and vitamin production. There are also indirect effects exerted at sites outside the GI tract, including the joints, lungs, and skin. Indirect effects most likely result from an impact on immunity, via changes in inflammatory mediators such as cytokines. Modulation of inflammatory responses may be related to regulating or modulating the immune system both locally in the GI tract. It is speculated that inflammation associated with rheumatoid arthritis may be modulated by the use of probiotics (Marteau *et al.,* 2001). Probiotic bacteria are

important in down regulating inflammation associated with hypersensitivity reactions in patients with atopic eczema and food allergy (Pohjavuori *et al.,* 2004). Perinatal administration of Lactobacillus rhamnosus GG decreased subsequent occurrence of eczema in at-risk infants by one-half (Isolauri *et al.,* 2000). In newborn infants, the initial bacteria to colonize the sterile GI tract may establish a permanent niche and have lasting impact on immune regulation and subsequent development of atopic disorders. It was suggested that

probiotics may enhance endogenous barrier mechanisms of the gut and alleviate intestinal inflammation, providing a useful tool for treating food allergy (Kalliomaki and Isolauri 2004). Probiotics have also been found to upregulate anti-inflammatory cytokines, such as interleukin-10, in atopic children (Pessi *et al.,* 2000).

HIV and Immune Function

Children with HIV infections have episodes of diarrhea and frequently experience malabsorption associated with possible bacterial overgrowth. Administration of L. plantarum 299v can be given safely to immune compromised hosts, may have a positive effect on immune response, and has the potential to improve growth and development. The immune response may further be enhanced when one or more probiotics are consumed together and work synergistically, as seems to be the case when Lactobacillus is administered in conjunction with Bifidobacteria (Cunningham-Rundles *et al.,* 2000).

Hypertension

Preliminary evidence indicates that probiotic bacteria or their fermented products may also play a role in blood pressure control, with animal and clinical studies documenting antihypertensive effects of probiotic ingestion (Nakamura *et al.,* 1995, 1996). Elderly hypertensive patients who consumed fermented milk with a starter containing Lactobacillus helveticus and Sacc. Cerevisiae experienced reductions in systolic and diastolic blood pressure (Hata *et al.,* 1996). Decreases in systolic and diastolic blood pressure and heart rate of hypertensive patients were administered powdered probiotic cell extracts (Nakamura *et al.,* 1995).

Cancer

Colorectal cancer (CRC) is a major cause of death from cancer in the western world. Approximately 70% of CRC is associated with environmental factors, probably mainly the diet. There is interest in the potential protective role of fermented milks containing probiotic cultures against CRC from human, animal and in vitro studies (Rowland 2004). Cohort studies have failed to detect significant effects, but most case–control studies favour a protective role of fermented milks against colon cancer. Interventional studies have shown a shift of intermediate markers of CRC risk in human subjects from a high- to low-risk pattern after ingestion of fermented milks or probiotics (Saikali *et al.,* 2004). Dietary supplementation with a strain of L. acidophilus significantly suppressed the total number of colon cancer cells in rats in a dose-dependent manner (De Santis *et al.,* 2000).

Control of Blood Cholesterol and Hyperlipidaemia

Accumulating evidence shows that probiotic bacteria may have a beneficial effect on blood lipid levels. One study in hypercholesterolemic mice showed that administration of low levels of L. reuteri for 7 days decreased total cholesterol and triglyceride levels by 38% and 40%, respectively, and increased the high-density lipid:LDL ratio by 20% (Taranto *et al.,* 1998).

Conditions of the Genitourinary Tract

In a recent study of bacterial cultures isolated from women with recurrent episodes of bacterial vaginosis, four different strains of lactobacilli demonstrated inhibitory activity against the bacterial species, possibly by producing an acidic environment (McLean and Rosenstein 2000). In addition, a number of observational studies have correlated vaginal health with the presence of lactobacilli (Reid and Bruce 2001b; Cadieux *et al.,* 2002). The colon might thus be a source of beneficial as well as harmful bacteria for the urinary and genital tracts. Controlled clinical studies are needed to substantiate these preliminary findings. Both oral probiotics and vaginal suppositories of probiotics have been shown to reduce the incidence of recurrent urinary tract infection (McLean and Rosenstein 2000). One study points to vaginal contamination with faecal flora as the possible rationale for the effectiveness of this therapy (Cadieux *et al.,* 2002).

Helicobacter pylori Infections

Lactobacillus salivarius capable of producing high amounts of lactic acid, which can inhibit the growth of H. pylori in vitro. It was found that the higher the level of lactic acid production by Lactobacillus, the more potent was the effect on reducing H. pylori's urease activity. The use of probiotics in the field of H. pylori infection has been proposed for improving eradication rate and tolerability and for compliance of multiple antibiotic regimens used for the infection (Filippo *et al.,* 2001). An inhibition of H. pylori infection was also shown in humans consuming Lactobacillus johnsonii (Marteau *et al.,* 2001).

Inflammatory Bowel Disease

Studies have shown an improvement in symptoms of IBD, pouchitis and ulcerative colitis with consumption of certain strains of lactobacilli (Femia *et al.,* 2002;). Lactic acid bacteria may improve intestinal mobility and relieve constipation possibly through a reduction in gut pH (Sanders and Klaenhammer 2001). It has also been reported that probiotic combination therapies may benefit patients with IBD (Schultz and Sartor 2000). The use of probiotics in the field of H. pylori infection has been proposed for improving eradication rate and tolerability and for compliance of multiple antibiotic regimens used for the infection (Filippo *et al.,* 2001). An inhibition of H. pylori infection was also shown in humans consuming *Lactobacillus johnsonii* (Marteau *et al.,* 2001).

Irritable Bowel Syndrome

Probiotics exhibit a direct effect in the gut in the treatment of inflammatory and functional bowel disorders. In one of the most common functional bowel disorders, irritable bowel syndrome, *L. plantarum* 299v and DSM 9843 strains were shown in clinical trials to reduce abdominal pain, bloating, flatulence, and constipation (Steidler *et al.,* 2000). It was also observed that *Sacc. boulardii* decreased diarrhoea in irritable bowel syndrome, but was not effective in alleviating other symptoms of the syndrome (Marteau *et al.,* 2001). Recent study showed a potential role of the intestinal microbiota in the modulation of inflammation in the intestine and joints. Normal gut physiology is moulded by the interaction between the intestinal microbiota and the host's GI tissues, including motility, absorption and secretion, and intestinal permeability (Verdu and Collins 2004).

Efficacy and Safety of Probiotics

In spite of inherent difficulties establishing good measures of probiotic efficacy, studies on lactose intolerance, diarrhoea and colon cancer show that a daily dose of lactic acid bacteria

is needed for any measurable effect. Unfortunately, the concentration of probiotics in food products varies tremendously and there are currently no national standards of identity for levels of bacteria required in yogurt or other fermented products. Epidemiological data on the safety of dairy products (Rolfe, 2000) and a thorough review of the safety data on probiotics (Ouwehand *et al.,* 2002) suggests no evidence of probiotics being involved with human infections. However, there always remains the possibility that probiotic consumption can cause infection and that individuals will respond in different ways to a specific strain. The food industry will need to carefully assess the safety and efficacy of all new species and strains of probiotics before incorporating them into food products.

Future Implications of Probiotics

In spite of the problems with dosage and viability of probiotic strains, lack of industry standardization and potential safety issues, there is obviously considerable potential for the benefits of probiotics over a wide range of clinical conditions. Ongoing basic research will continue to identify and characterize existing strains of probiotics, identifying strain-specific outcomes, determine optimal doses needed for certain results and assess their stability through processing and digestion.

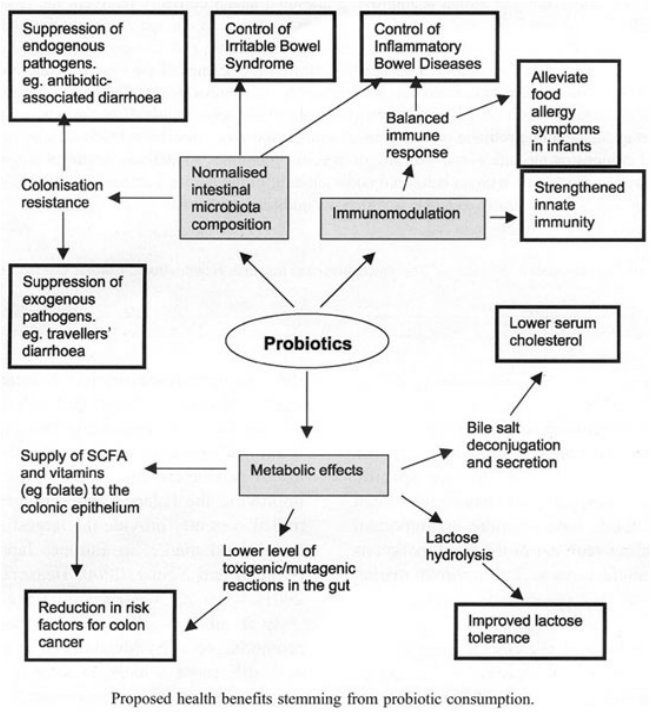

Fig. 1. Shows the various health benefits from probiotic consumption (Parvez *et al.*, 2006)

Gene technology will certainly play a role in developing new strains, with gene sequencing allowing for an increased understanding of mechanisms and functionality of probiotics.
In addition to such basic research, industry- centered research will focus on prolonging the shelf-life and likelihood of survival through the intestinal tract, optimizing adhesion capacity and developing proper production, handling and packaging procedures to ensure that the desired benefits are delivered to the consumer. Over time, new food products containing probiotics will emerge such as energy bars, cereals, juices, infant formula and cheese, as well as disease-specific medical foods. The establishment of standards of identity for probiotic containing food products will serve to accelerate the development and availability of these food products.

Application of Probiotic Bacteria in Food Preparation

Dairy Products

Probiotic like most functional foods are classed as food or food supplements. Probiotics are most commonly suited to use in Yoghurts, Yoghurt drinks, capsules or tablets. Thus the use of probiotic cultures in fermented dairy products and function of Probiotics as a new challenge for the next millennium (Roy, 1997). Probiotic are most commonly suited to use in Yoghurts, Yoghurt drinks, capsules or tablets. Variation of the traditional type of the Yoghurts are found in fluid Yoghurt, frozen Yoghurt, Fruit Yoghurt and Flavored Yoghurt (Bhattacharya and Ray 2002). The prospects of Lactic acid based beverages like Yoghurt, frozen Yoghurt, fruit juice Yoghurt, Flavored Yoghurt in world wide shows a good potential market. At the same time the nutritive value is far greater than that of synthetic beverages. Yogurt has been shown by many authors to be more digestible than milk. Bresslaw and Klen (1973) used a simulated gastric digestion system to asses the protein digestibility of yogurt and of the raw milk mixture at various stages during processing. Their results show decrease in protein particle size and an increase in soluble protein, non-protein nitrogen and free amino acids during processing and yogurt manufacture.

Probiotic dairy beverages containing fruits or vegetables were prepared and their physicochemical and sensory properties analyzed during storage in sterilized bottles at 5 ± 1^{o}C for 10 days. The beverages consisted of fermented buffalo milk prepared using *Bifidobacterium lactis* as starter, together with 15-25% tomato juice, carrot concentrate or pureed pumpkin, strawberries, black mulberries or red grapes. pH values of beverages decreased throughout storage, whereas TS values depended on the nature and amount of the fruit or vegetable preparation added. Beverages fortified with carrot and pumpkins were found to be a good source of beta-carotene. Lycopene levels were enhanced by addition of tomato, whereas strawberries, black mulberries and red grapes provided anthocyanins. All beverages contained levels of vitamin C, minerals and *Bifidobacterium* (approx.107 cfu/g) sufficient to provide health benefits. Sensory analysis revealed that the beverages had acceptable flavors, with scores higher than those achieved by the control (Salem *et al.,* 2006).

Fruit Juices and Beverages

Fruit juices are particularly good source of vitamins and minerals but combination with probiotic would make complimentary and alternative to medicines. Lactic acid combination with fruit juice offer one of the best incremental growth opportunities for beverages. Such combination would serve as a great source of replenishment of lost fluid in the human body. Fruit juices are deemed to be suitable vehicle for probiotic bacteria, as they are not exposed to acidic stomach conditions for too long (residence time is short), juices already enjoy a healthy image and they are a good medium for bacterial survival (Post, 2002). Fruit juice is seen as a natural, healthy product and/or food or beverage component, capable of offering the consumer something of

pleasure and also a bonus factor, for which will pay a premium price. Probiotics for the fruit juice industry to remain one step ahead of the market, in terms of product conceptualization and developments (Kraemer and Obeid, 2001). The prospect of probiotic based fruit beverages in India shows a good potential. At the same time the nutritive value of real fruit beverages is far greater than that of synthetic beverages which are being bottled and sold in large quantities throughout the country. Fruit juices and juice drinks are an important component of the human diet. People choose juices and juice drink for many reasons, including relieving thirst, refreshment, nutrition benefit, good taste, as a sport drink or fluid replenishes and as an alternative to carbonated soft drinks (Choudhury, 2004).

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Vegetable Juices

Growth of lactic acid bacteria with probiotic properties, in a vegetable juice medium (comprising a blend of onion, carrot and cabbage juice) was studied and found suitable (Savard *et al.,* 2003). Suitability of larger beets as a raw material for producing probiotic beet juice with *Lactobacillus plantarum, L. delbrueckii, L. casei and L. acidophilus* was successfully investigated (Kyung *et al.,* 2005).

Cereal Products

Most probiotic foods at the markets worldwide are milk based and very attempts are made for development of probiotic foods using other fermentation substrates such as cereals (Marklinder and Lonner, 1992).Growth kinetics of 4 potentially probiotic strains (*Lactobacillus fermentum, L. reuteri, L. acidophilus and L. plantarum*) in malt, barley and wheat media were successfully investigated (Charalampopoulos *et al.,* 2002).

Chewing Gums

Chewing gum products comprising a chewable base and a probiotic agent, preferably a lactic acid-producing microorganism, and more preferably a spore-forming lactic acid producing microorganism was very popular. Prolonged use of these chewing gum products allows reduction of bad breath (Gonzalez, 2003).

Ice Creams

The functions of probiotic microorganisms incorporated into ice cream, the use of inulin and oligofructose as prebiotic ingredients, and some applications of probiotics and prebiotics, e.g. in the manufacture of yoghurt ice cream, were reviewed and found to be beneficial (Polak, 2001).

Poultry Meat Products

The Various aspects of probiotic lactobacilli and their application in poultry meat production have been found to have been very useful (Parmod and Jhari, 1998). Several Lactic acid bacteria associated with meat products are important natural bacteriocin producers. *Lactobacillus curvatus* CRL705 used as a protective culture in fresh beef which is effective in inhibiting *Listeria innocua* and *Brochothrix thermosphacta*. The mechanism of action for probiotics effect on poultry meat and its product quality were found to be successful (Castellano, 2008).

Recent Trends in Probiotics

During recent years, the popularity and demand for non milk based probiotic formulations has increased. Buyers ask to extend the production and marketing of products different from milk derivatives, in particular fruit juices, chocolates, cereals, ice creams and sausages are desired (Saxelin, 2008). The development of non dairy probiotic products is a challenge to the food industry in its effort to utilize the abundant natural resources by producing high quality functional products. In this respect probiotics containing baby foods or confectionary formulations have been developed by adding the strains as additives. Scientists have embarked on extensive studies to isolate and characterized micro organisms associated with production of indigenous fermented foods with the possibility of exploiting their industrial potentials (Leisner *et al.,* 2001; Adan and tan, 2007)

Status of Probiotics in India

In India, probiotics are often used as animal feed supplements for cattle, poultry and piggery. This requirement is also met by importing probiotics from other countries. It is rarely used for human beings – Sporolac, *Saccharomyces boulardii* and yogurt (*L. bulgaricus + L. thermophillus*) are the most common ones. Sporolac is manufactured using *Sporolactobacilli*. Lactobacilli solution is an example of a probiotic, usually given to paediatric patients in India. The latest and recent addition to the list of probiotics in India is ViBact (which is made up of genetically modified *Bacillus mesentricus*), which acts as an alternate to B-complex capsules. In India, only sporulating lactobacilli are produced and they are sold with some of the antibiotic preparations. Probiotics in India generally comes in two forms, milk and fermented milk products with the former occupying 62% of the market share and later having 38% market share (Indian consumer survey, 2010). Indian probiotic products currently are Dahi (Indian yoghurt), flavoured milk and butter milk. Major pharmaceuticals companies have become active in this space and are devising newer drugs and products; however current drugs are predominant in the area of neutraceuticals. Players are also devising packaged products like probiotic-based nutritional supplements aimed at people with special needs such as lactation, pregnancy, immunodeficiency etc.;

another set of products are the over the counter (OTC) variety of probiotic formulations generally aimed at pediatric and geriatric patients (Balaji and Arunachalam, 2011). Indian probiotic market is valued at $2 million as per 2010 estimates and it is poised to quadruple by 2015 due to the advent of Indian and multinational companies coming in to the fray. With their advent, the Indian probiotic market turnover is expected to reach $8 million by the year 2015.

The existing probiotic market in India majorly comprises of three segments, urban chain, young adults and people with special needs such as pregnancy, lactation, immunodeficiency, geriatry etc. India at present accounts for less than 1% of the total world market turnover in the probiotic industry and it is a huge deficit considering the fact that India has the highest cattle population and India being the world's highest milk producer. India is a challenging market as it has not been exposed to probiotic products as have Western and other Asian countries. Countries like Japan, UK and some other countries in Asia have been part of the growing probiotic market since the early 1980s. But, in India, commercial probiotic foods only started cropping up on store shelves around 2007. Hence, it will be a while before we are able to overcome hurdles such as lack of awareness, retail mind set, lack of cold chain and such facilities. The global probiotic market today is $17 billion, whereas the market size in India is just about Rs 100 crores with a handful of players. While probiotics in the form of drugs are widely accepted, probiotic foods are still viewed with skepticism. Acceptance is growing slowly, but it will be a long while before people start consuming bacteria for breakfast. Excellent growth opportunities exist for domestic and foreign companies to capitalize the prevailing situation and produce resounding results.

Conclusion

Today probiotics are available in a variety of food products and supplements. In the United States, food products containing probiotics are almost exclusively dairy products – fluid milk and yogurt – due to the historical association of lactic acid bacteria with fermented milk. Indian probiotic market presents a rosy picture in the near future. There are many probiotic products at the market place and most have supporting evidence behind the advertized health claims. New legislation governing the labeling of probiotics, such as indicating the species, strain and number of bacteria present is likely to come into force in the near future. Probiotics should not be considered a panacea for health, but can be incorporated into a balanced and varied diet to maximize good health. Although there are formidable challenges to be encountered, the prospects of the market expanding in a steadfast way look bright.

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