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Probiotic, Prebiotic and Synbiotics in the Prevention of Lifestyle Disorders

Abhishek Chauhan[1]*, Anuj Ranjan[1], Rupesh Kumar Basniwal[2] and Tanu Jindal[1]

[1]Amity Institute of Environmental Toxicology, Safety and Management, Amity University, Sector-125, Noida, Uttar Pradesh, India
[2]Amity Institute of Advanced Research and Studies, Amity University, Sector-125, Noida, Uttar Pradesh, India
**Corresponding author*

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A B S T R A C T

Probiotics, prebiotics and synbiotics are the new concepts that have been developed to amend the target gastrointestinal microflora balance required for growth and development. Globally awareness about theprobiotic foods israpidly increasing and consumers are now very much conscious about their health and the food that they eat. Evidence for various beneficial roles of the intestinal microbiota in human health and disease is expanding rapidly. Perturbation of the intestinal microbiota may lead to chronic diseases such as autoimmune diseases, colon cancers, gastric ulcers, cardiovascular disease, functional bowel diseases, and obesity. Several scientific research studies rendering that the gut health in general is a key sector for maintaining the overall health of people, whose microbiota plays a key role in metabolism and nutrient absorption. A large of number of research organization are working on several aspects including Genomics and bioinformatics of probiotic microorganisms to produce multifunctional probiotic with one organisms or the mixture of several strains. Some effects attributed to selected probiotics or prebiotics have been proved by clinical trials, while others have been acquired on the basis of in vitro tests which need to be replicated in vivo in order to be validated. In Indian context so far Yakult a big brand of Probiotic foods sold in metro city against the huge increasing demands. Probiotic microorganisms especially *Lactobacillus* and *Bifidobacterium* have been suggested to be associated with a number of health benefits. The present review is a collection of scientific information to enrich probiotic research and development internationally.

Introduction

In 1908, Dr Elie Metchnikoff, a Russian biologist first introduced the concept of probiotics. Probiotic terms derived from Greek words Pro (favor) and bios (life).Lilly and Stillwell in 1965 describe "substances secreted by one microorganism which stimulates the growth of another" and thus was contrasted with the term antibiotic. It may be because of this positive and general claim of definition that the term probiotic was subsequently applied to other subjects and gained a more general meaning. Probiotics are defined as live microorganisms which when administered in adequate amounts confer a health benefit on the host (FAO and WHO, 2002) Whereas Prebiotic are the food components which promote the growth and proliferation of useful bacteria in the digestive

system. These Prebiotics are not easily digested by human and therefore indirectly very essential for life. Synbiotic probably a new term, it is a synergistic combination of Pre and Probiotic. The normal human digestive tract contains more than 400 different types of bacteria that promote a healthy digestive system. The global probiotic market generated US $15.9 billion in 2008 and is expected to be worth US$ 32.6 billion by 2014 with a compound annual growth rate of 12.6% from 2009 to 2014. On the other hand the probiotic product industry in India was estimated to be around Rs 20.6 million with a projected annual growth rate of 22.6% until 2015 (ICMR-DBT, 2011).The World Health Organization (WHO) estimates 8.1 million deaths occur yearly in children (<5 years of age) with diarrhea accounting for 14% of those deaths. Lactic acid bacteria such as lactobacilli are most commonly used as Probiotic bacteria bifidobacteria and other bacilli and certain yeast may also be used. Probiotic microorganisms (e.g. *Lactobacillus rhamnosus* GG, L. reuteri, bifidobacteria and certain strains of *L. casei* or the L. acidophilus-group) are used in Probiotic food, particularly fermented milk products, or have been investigated--as well as *Escherichia coli* strain Nissle 1917, certain *enterococci* (*Enterococcus faecium* SF68) **(**De Vrese and Schrezenmeir, 2008). Probiotic products are available in the form of Foods such as fermented milk, yoghurt and ice-cream. Powder, capsule and tablets as a dietary supplements and pharmaceutical formulations with specific therapeutic claims as a drug. Fermented milks are commonly included in many different national food dietary guidelines that include the dairy category (Antoine, 2014). Several studies in animal models and in human population have confirmed that the utilization of probiotics is effective in various medical conditions such as lactose intolerance, antibiotic-induced diarrhea, gastroenteritis, constipation, and genitourinary tract infections (Iannitti and Palmieri, 2010). Moreover, accumulating evidence suggests that the ingestion of probiotics may be able to play a preventive role in the onset of CRC (Rafter, 2004). This review is purely intended at providing an outline of the possible scientific information nationally as well as internationally. It is a cumulative effort to enrich students, researchers, Scientists and Technologists as far as basic to current applied information in this area.

Probiotic microorganisms

Probiotic cultures are described as live microbial feed supplements that improve intestinal microbial balance. The gastrointestinal tract is estimated to contain approximately 100 trillion microbial cells (Ramakrishna, 2014).The 'normal' gut microflora consists of bacterial species with morphological, physiological and genetic features that let it to colonize and multiply under particular conditions at certain sites, coexist with other colonizing microorganisms and competitively inhibit the growth of pathogenic bacteria. Microbial population of the gut is very sparse in the stomach due to the luminal acidity and vigorous peristalsis. The microbial population increases in density as we proceed from the duodenum (10^1-10^3 organisms/ml) to jejunum (10^4-10^6 organisms/ ml) to ileum (10^5-10^7 organisms/ml). Microbial Concentration in the large intestine reaches 10^{11}-10^{12} organisms/g of stool (Ramakrishna, 2014). Some environmental factors such as diet and drugs can alter the composition of the resident microbiota, with consequent dysmicrobia and negative implications for the health of the individual. The colonic microflora is very rich and dominated by strict anaerobic bacteria such as *Bacteroides* spp., *Fusobacterium* spp., *Clostridium* spp, and many others (Uccello *et al*., 2012). This is a particular concern, given

thathigh levels (at least 10^7per gram or ml) of live micro-organisms are recommended for probiotic products. Antoine in 2014 has reported that probiotics belongs to different phyla: the phylum firmicutes with the order Lactobacillacae, phylum actinobacteria and phylum proteobacteria. Scientists are in Search for new strain for the expansion of the products with novel strain on microorganisms.

Intrinsic and Extrinsic Factor Affecting Probiotic Viability in Food

Probiotic microorganisms are affected by several intrinsic and extrinsic factors. Therefore it is very much useful to study these factors in all stage of Probiotic food manufacturing. Following key factors have been described.

Temperature: Microorganisms are divided on the basis of temperature, hence it is very important factor that is directly affects the viability of Probiotic microorganisms. Therefore, the products (raw material, finished or any stage) are being stored at lower temperature instead of High. Several national and international guidelines are used to maintain the optimum temperature during the all stages of Probiotic manufacturing.

Oxygen: There are certain strains i.e. *Bifidobacterium* which are anaerobic and presence of oxygen can stop their growth and survival. The amount of oxygen sensitivity varies from one strain to another which can be studied practically. Obligate anaerobic Probiotic strains cannot survive but facultative strains i.e. *Lactobacilli* can tolerate more oxygen. Therefore, as per the national and international guidelines it is recommended that for Oxygen sensitive strains, it is desirable to diminish such process which involve aeration.

Water Content: It is also a very significant factor for probiotic survival in the foods. Water Moisture and osmotic stress are controlled through prerequisites. It is reported that when the moisture and water content of the product is higher, the survival of probiotic microorganisms would be lower. To achieve good quality and stability water content is kept as per the limitation of guidelines to avoid product drying.

pH: In food and dairy industry, pH of the product is controlled for long shelf life of probiotic products. There are certain important strains of microorganisms which produced organic acid as end product of carbohydrate fermentation and thereby accelerate the survival of probiotic microorganisms.

Freeze and Thawing: These factors directly affects of the survival of probiotic strains as freezing can be harmful and cells may become more vulnerable to environmental stress. Protectants are added in the culture before frozen or dried to prevent cell injury and damage. Other freezing methods can be adopted after validation studies.

Shear Force: Cell disruption and loss of viability may take place during production process such as high-speed blending or homogenization, Gram-positive bacteria due to thick cell wall are able to tolerate the shear forces.

Physiological State of Probiotic Microorganisms: It is also a very key factor as probiotic microbial stains have their own intrinsic tolerance to environmental condition. Moreover, conditions depends the maintenance of culture and their passage number at the time of preparation of porobiotic formulation and products.

Synergistic Ingredient, Toxicity and Inhibition: Selection of carrier matrix should have synergistic interaction with probiotic microorganisms. Antimicrobial substance (Organic acid, salt, nitrates and preservative) can inhibit probiotic microorganisms during their storage. Certain antimicrobial effectiveness tests are recommended to determine the antimicrobial nature of the raw products. However, the ingredients must support to improve the growth of selected Probiotic strains.

Guidelines for the Evaluation of Probiotic in Food (adopted from Koshia and Sesikeran, 2014)

1. Strain Identification by phenotypic and genotypic methods (a) Genus, species, and Strain (b) Deposit strain in an internationally recognized collection.

2. Screening of Potential Probiotic strains (a) *In Vitro* Tests

3. *In Vivo* Studies in validated animal models for: (a) Safety (b) Efficacy

4. *In Vivo* study in humans for clinical evaluations (a) Phase 1 Safety (b) Phase 2 efficacy (c) Phase 3 Effectiveness.

5. **Probiotics Foods:** Labeling requirements (a) Genus, Species, Strain (b) Minimum viable numbers of Probiotics at the level at which efficacy is claimed and at the end of shelf life (c) Health Claims (d) Serving size for efficacy (d) Storage condition.

Probiotic Products and Producer (PPP): A number of microbial strains are now used for the preparation of probiotic dinks and other products. Name of the microbial strains, product brand and producer are given in the Table 1.

Product Brand with Mixture of Microbial Strains: Several manufacturer and R&D organization are using the combination of microbial strains for new or better probiotic products. Some of the product brands are already developed (Table 2).

Benefits and Clinical Application: Probiotic microorganism's exhibits several immunological and non immunological benefits are given in the Table: 3. It has been widely reported that the probiotic preparation and products are known to reduce or prevent several clinical disorders such as Cardiovascular disease, Colon cancer, Diarrhea, Prevention of acute diarrhea: Antibiotic-associated diarrhea: Radiation-induced diarrhea etc. Research studies throughout the world have been carried out to evaluate probiotic products against more human disorders. Many studies have shown that Probiotics can stimulate the immune system, decrease serum cholesterol, alleviate lactose intolerance, decrease diarrheal incidence, control infections. Some of the common disorders are describe as under: Probiotic bacteria release a variety of chemical compounds that are inhibitory to both gram-positive and gram negative bacteria. These include bacteriocins, siderophores, lysozymes, proteases, hydrogenperoxides etc. Bacteriocins are proteinaceous compounds produced by a wide range of bacteria exhibiting antimicrobial activity against a select range of other bacteria (Jothi *et al*., 2012).

Prebiotics

Prebiotics are food ingredients which are indigestible in the upper GI tract and reach the colon to beneficially influence the host by selectively promoting the growth and/or activity of certain bacteria in the colon. Prebiotics are employed to promote both beneficial bacteria which are already established in the colon as well as externally

administered probiotic bacteria. Prebiotics are also present in low amount in many fruits and vegetables including leeks, Jerusalem artichokes, chicory, onion, garlic, banana, and asparagus. All prebiotics are carbohydrates, and there are many different carbohydrates marketed world-wide as prebiotics, Oligosaccharides such as lactulose, galactooligo-saccharides, inulin, fructo-oligosaccharides, and other food carbohydrates are some of the well known examples of prebiotics (Soccol *et al*., 2010).

Product with recommended dose: It has been well said that the excess of everything is harmful, even high amount of salt become toxic therefore, dose of the product play a crucial role for better benefits. Several strains have been selected or under identification are being used in several products. The detail information is summarized in Table 4.

Relevance of Probiotics in Aquaculture and Animal Feed

Now a day, there has been a considerable interest in using some probiotic microorganisms and organic acids as an alternative to the use of antibiotics in feed. Animal feed companies and researchers have been looking for alternative products and strategies that can help to maintain animal gut health in order to preventor reduce the prevalence of pathogens in the food chain.

Table.1 Example of Probiotic strains in Products (adopted from World Gastroenterology Organisation Practice Guideline, 2008)

Microbial Strains	Product Brand	Producer
Bifidobacterium animalis DN 173 010	Activia	Danone/Dannon
Bifidobacterium animalis subsp. lactis Bb-12		*Chr. Hansen*
Bifidobacterium breve	YakultBifiene	Yakult
Bifidobacterium infantis 35624	Align	Procter & Gamble
Bifidobacterium lactis HN019 (DR10)	Howaru Bifido	Danisco
Bifidobacterium longum BB536		Morinaga Milk Industry
Enterococcus LAB SF 68	Bioflorin	Cerbios-Pharma
*Escherichia coli*Nissle 1917	Mutaflor	Ardeypharm
Lactobacillus acidophilus LA-5		Chr. Hansen
Lactobacillus acidophilus NCFM		Danisco
Lactobacillus casei DN-114 001	Actimel, DanActive	Danone/Dannon
Lactobacillus casei CRL431		Chr. Hansen
Lactobacillus casei F19	Cultura	Arla Foods
Lactobacillus casei Shirota	Yakult	Yakult
Lactobacillus johnsonii La1 (Lj1)	LC1	Nestlé
Lactococcus lactis L1A	Norrmejerier	
Lactobacillus plantarum 299V	GoodBelly, ProViva	NextFoodsProbi
Lactobacillus reuteri ATTC 55730	Reuteri	BioGaia Biologics
Lactobacillus rhamnosus ATCC 53013 (LGG)	Vifit and others	Valio
Lactobacillus rhamnosus LB21	Verum	Norrmejerier
Saccharomyces cerevisiae (boulardii) lyo	DiarSafe, Ultralevure, and others	Wren Laboratories, Biocodex, and others

Table.2 Example of Probiotic strains in Products tested as a mixture (adopted from World Gastroenterology Organisation Practice Guideline, 2008)

Microbial Strains Tested as a Mixture	Product Brand	Producer
Lactobacillus acidophilus CL1285 &*Lactobacillus casei* Lbc80r	Bio K+	Bio K+ International
Lactobacillus rhamnosus GR-1 &*Lactobacillus reuteri* RC-14	FemDophilus	Chr. Hansen
VSL#3 (mixture of 1 strain of *Streptococcus thermophilus*, four *Lactobacillus* spp., & three *Bifidobacterium spp*. strains VSL#3	Sigma-Tau	Pharmaceuticals, Inc.
Lactobacillus acidophilus CUL60 &*Bifidobacterium bifidum* CUL 20	-	-
Lactobacillus helveticus R0052 &*Lactobacillus rhamnosus* R0011	A'Biotica and others	Institut Rosell
Bacillus clausii strains O/C, NR, SIN, and T	Enterogermina	Sanofi-Aventis

Table.3 Benefits and Clinical Application (adopted from World Gastroenterology Organisation Practice Guideline, 2008)

Immunologic benefits	Activate local macrophages to increase antigen presentation to B lymphocytes and increase secretory immunoglobulin A (IgA) production both locally and systemically ;Modulate cytokine profiles;Induce hyporesponsiveness to food antigens
Non immunologic benefits	Digest food and compete for nutrients with pathogens; Alter local pH to create an unfavorable local environment for pathogens; Produce bacteriocins to inhibit pathogens; Scavenge superoxide radicals; Stimulate epithelial mucin production; Enhance intestinal barrier function; Compete for adhesion with pathogens; Modify pathogen-derived toxins
Clinical Application	Cardiovascular disease, Colon cancer, Diarrhea, Prevention of acute diarrhea:Antibiotic-associated diarrhea:Radiation-induced diarrhea, Eradication of Helicobacter pylori, Allergy, Hepatic encephalopathy, Inflammatory bowel disease (IBD)Irritable bowel syndrome (IBS)Lactose malabsorption, Necrotizing enterocolitis, Nonalcoholic fatty liver disease, Prevention of systemic infections

Table.4 Probiotics and Prebiotics in gastroenterology (adopted from World Gastroenterology Organisation Practice Guideline, 2008)

Disorder	Product	Recommended dose	References
Treatment of acute infectious diarrhea in children	*L. rhamnosus* GG	10^{10}–10^{11} cfu, twice daily	Allen *et al*., 2004
	L. reuteri ATTC 55730	10^{10}–10^{11} cfu, twice daily	Allen *et al*., 2004
	L. acidophilus + *B. infantis* (Infloran strains)	10^{9} cfu each, three times daily	Lee *et al*., 2001
	S. cerevisiae (boulardii) lyo	200 mg, three times daily	Allen *et al*., 2004
Treatment of acute infectious diarrhea in adults	*Enterococcus faecium* LAB SF68	10^{8} cfu, three times daily	Allen *et al*., 2004
Prevention of antibiotic-associated diarrhea in children	*S. cerevisiae* (Boulardii) lyo	250 mg, twice daily	Sazawal *et al*., 2006
	L. rhamnosus GG	10^{10} cfu once or twice daily	Sazawal *et al*., 2006
	B. lactis Bb12 + *S. thermophiles*	10^{7} + 10^{6} cfu/g of formula	Sazawal *et al*., 2006
Prevention of antibiotic-associated diarrhea in adults	*Enterococcus faecium LAB SF68*	10^{8} cfu, twice daily	Lee *et al*., 2001
	S. cerevisiae (boulardii) lyo	1 g or 3 × 10^{10} cfu per day	Sazawal *et al*., 2006
	L. rhamnosus GG	10^{10}–10^{11} cfu, twice daily	Sazawal *et al*., 2006
	L. casei DN-114 001in fermented milk with L. bulgaricus + *S. thermophiles*	10^{10} cfu, twice daily	Hickson *et al*., 2007
	B. clausii (Enterogermina strains)	2 × 10^{9} spores, three times daily	Nista *et al*., 2004
	L. acidophilus CL1285 + *L. casei Lbc80r*	5 × 10^{10} cfu, once daily	Beausoleil *et al*., 2007
Prevention of nosocomial diarrhea in children	*L. rhamnosus GG*	10^{10}–10^{11} cfu, twice daily	Sazawal *et al*., 2006
	B. lactis BB12 + *S. thermophiles*	10^{8} + 10^{7} cfu/g of formula	Sazawal *et al*., 2006
	B. lactis BB12	10^{9} cfu, twice daily	Sazawal *et al*., 2006
	L. reuteri ATTC 55730	10^{9} cfu, twice daily	Sazawal *et al*., 2006
Prevention of C. difficile diarrhea in adults	*L. casei DN-114 001 in fermented milk with L. bulgaricus* + *S. thermophiles*	10^{10} cfu, twice daily	Hickson *et al*., 2007
	L. acidophilus + *B. bifidum (Cultech strains)*	2 × 10^{10} cfu each, once daily	Beausoleil *et al*., 2007
	S. cerevisiae (boulardii) lyo	2 × 10^{10} cfu per day	Sazawal *et al*., 2006
	Oligofructose	4 g, three times per day	Lewis *et al*., 2005

Adjuvant therapy for H. pylori eradication	*L. rhamnosus GG*	6×10^9 cfu, twice daily	Tong *et al*., 2007
	B. clausii (Enterogermina strains)	2×10^9 spores, three times daily	Tong *et al*., 2007
	AB yogurt with unspecified lactobacilli and bifidobacteria	5×10^9 viable bac, twice daily	Tong *et al*., 2007
	S. cerevisiae (boulardii) lyo	1 g or 5×10^9 cfu per day	Tong *et al*., 2007
	L. casei DN-114 001 in fermented milk with L. bulgaricus + S. thermophiles	10^{10} cfu, twice daily	Sýkora *et al*., 2005
Reduces symptoms associated with lactose maldigestion	*Regular yogurt with L. bulgaricus + S. thermophilus*	Yogurt not heat-treated after pasteurization contains suitable cultures to improve digestion of the lactose in the yogurt	Montalto *et al*., 2006
Alleviates some symptoms of irritable bowel syndrome	*B. infantis 35624*	10^8 cfu, once daily	O'Mahony *et al*., 2005
	L. rhamnosus GG	6×10^9 cfu, twice daily	Gawronska *et al*., 2007
	VSL# 3 mixture	4.5×10^{11} cfu, twice daily	Kim *et al*., 2005
	L. rhamnosus GG, L. rhamnosus LC705, B. breve Bb99, and Propionibacterium freudenreichii ssp. Shermanii	10^{10} cfu, once daily	Kajander *et al*., 2005
	B. animalis DN-173 010 in fermented milk with L. bulgaricus + S. thermophiles	10^{10} cfu, twice daily	Guyonnet *et al*., 2007
Maintenance of remission of ulcerative colitis	*E. coli* Nissle 1917	5×10^{10} viable bac, twice daily	Kruis *et al*., 2004
Prevention and maintenance of remission in pouchitis	VSL# 3 mixture of 8 strains (1 *S. thermophilus*, 4 *Lactobacillus*, 3 *Bifidobacterium*)	4.5×10^{11} cfu, twice daily	Gionchetti *et al*., 2003
Treatment of constipation	Lactulose	20–40 g per day	Schumann, 2002
	Oligofructose	> 20 g per day	Nyman, 2002
Prevention of necrotizing enterocolitis in preterm infants	*B. infantis, S. thermophilus,* and *B. bifidum*	0.35×10^9 cfu each strain, once daily	Deshpande*et al*., 2007
	L. acidophilus + B. infantis (Infloran strains)	10^9 cfu each, twice daily	Deshpande*et al*., 2007

Prevention of postoperative infections	Synbiotic 2000: 4 bacteria strains and fibers including the prebiotic inulin	10^{10} cfu + 10 g fibers, twice daily	Rayes *et al*., 2005
Treatment of hepatic encephalopathy	Lactulose	45–90 g per day	Schumann, 2002

Table.5 Relevance of Probiotics in Aquaculture and Animal Feed(adopted from Soccol1 *et al*. 2010)

Probiotic strain	Application	Probiotic effects	References
Bacillus subtilis, Bacillus licheniformis	shrimp production	Reduce stress, improve health, the quality of water, clean effluent water, control pathogenic bacteria and their virulence, stimulate the immune system, improve gut flora, substitute antibiotics, improve growth	Decamp and Moriarty 2006; Moriarty *et al*. 2005
Bacillus spp. and yeasts	mollusc production	minimize diseases caused by Vibrio spp. and Aeromonas spp., which results in mollusc mortality	Watson *et al*. 2008
Clostridium spp.	freshwater fish feed	Produces digestive enzymes, which facilitate feed utilization and digestion, antibacterial activity against pathogenic microorganisms	Bairagi *et al*. 2002
Bacillus spp., Saccharomyces cerevisiae	aquaculture	improve water quality and interaction with phytoplankton, possess adhesion abilities, produce bacteriocins, provide immunostimulation	Verschuere *et al*.2000
Bacillus spp., S. cerevisiae	Aquaculture	stimulate the growth of microalgae that produce organic extracts capable of inhibiting pathogens and vibrios, then some microalgae species produce the antibiotic thiotropocin against some pathogens	Naviner *et al*. 1999; Kawano *et al* 1997
S. cerevisiae	aquaculture	immunostimulatory activity,	Verschuere *et*

		produces inhibitory substances against pathogens	*al*.2000
Bifidobacterium longum, L. plantarum	chicken feed	produce antimicrobial substances against pathogens such as Campylobacter	Santini *et al*. 2010
Pediococcusacidilactici, Lactococcuslactis, L. casei, Enterococcus faecium	weaned piglet	stimulate animal growth, reduce coliform counts by the production of antimicrobial metabolites	Guerra *et al*. 2007
S. cerevisiae	lactating ruminants	facilitates increased mobilization of body reserves, increases milk fatty acid production	Reverdin *et al*. 1996
S. cerevisiae	camel feed	increases total mass gain and improves feed utilization	Mohamed *et al*. 2009
S. cerevisiae	buffalo feed	increases digestion of cellulose	Kumar *et al*. 1994
Pediococcusacidilactici	broiler chickens	improves performance, reduces serum cholesterol	Alkhalf *et al*. 2010
Lactobacillus, Bifidobacterium, Streptococcus, Enterococcus ssp.	layer hens	reduces mortality	Yörük *et al*. 2004
L. sporogenes	broiler chickens	reduces serum total cholesterol and triglycerides	Panda *et al*. 2006
Lactobacillus ssp.	chicken feed	immunomodulating properties	Koenen *et al*. 2004
Lactobacillus spp., Bacillus spp.	poultry feed	reduces zoonosis in poultry meat	Santini *et al*. 2010
L. reuteri LPB P01-001	swine feed	mass gain, antimicrobial activity against E. coli and S. aureus	Pancheniak, and Soccol, 2005
Enterococcus faecalis, E. faecium	canine feed	bacteriocin-like inhibitory substances, antimicrobial activity against Gram(+) bacteria, colonize transiently	Strompfová *et al*. 2004

The use of probiotics and commercial products containing probiotics in aquaculture (e.g. shrimp production). In 2000 Verschuere and his co workers suggested a new definition

of a probiotic for aquatic environments: 'a live microbial adjunct which has a beneficial effect on the host by modifying the host-associated or ambient microbial community, by ensuring improved use of the feed or enhancing its nutritional value, by enhancing the host's response towards disease, or by improving the quality of its ambient environment', or that 'a probiotic is an entire microorganism or its components that are beneficial to the health of the host' (Irianto and Austin, 2002).

Quality Control and Quality Assurance: It is very utmost requirement that all the probiotic products must manufactured under Good manufacturing practices (GMP). It has also been reported that there are several microorganisms which can spoil the probiotic formulation and products, therefore at each level control of hazards and their detection must be carried out as per the available guidelines for probiotics. Assurance of raw material and other key parameters is equally significant for maintaining the quality of products in order to achieve increased demands of probiotics.

Conclusion and Path Forward: It can be concluded that prebiotics have great potential as agents to improve or maintain a balanced intestinal micro flora to enhance health and wellbeing. They can be incorporated into many foodstuffs. Thorough comparative studies will allow intelligent choices in incorporating prebiotics into functional foods and that should increase confidence among consumers and regulatory authorities. Prebiotics will be a unique tool to create, both in experimental animals and in humans, colonic micro flora with controlled compositions that will then be correlated with specific physiological conditions. Variety of probiotics studies are now on fast track across the age spectrum, in an ever increasing range of diseases, using a variety of routes of administration. The future is going to be challenging but promising, since tools for probiotic research are now available. Much work has already been accomplished to help us understand probiotics and the manner in which they function. Therefore the field of probiotics, prebiotics and synbiotics may potentially open a new branch of science.

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