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A REVIEW ON ''PROBIOTICS: THEIR POTENTIAL IMPACT ON HUMAN HEALTH''

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ABSTRACT

Probiotics are “the live microorganisms which when administered in adequate amounts confer a health benefit on the host”. Probiotics are often called "good" or "helpful" bacteria because they help keep our gut healthy. Probiotics are naturally found in our body. We can also find them in some foods and supplements. When we lose "good" bacteria in our body (like after you take antibiotics, for example), probiotics can help replace them. They can help balance our "good" and "bad" bacteria to keep our body working like it should. Most probiotics fall into the group of organisms' known as lactic acid-producing bacteria and are normally consumed in the form of yogurt, fermented milks or other fermented foods. Some of the beneficial effect of lactic acid bacteria consumption include: (i) improving intestinal tract health; (ii) enhancing the immune system, synthesizing and enhancing the bioavailability of nutrients; (iii) reducing symptoms of lactose intolerance, decreasing the prevalence of allergy in susceptible individuals; and (iv) reducing risk of certain cancers. The mechanisms by which probiotics exert their effects are largely unknown, but may involve modifying gut pH, antagonizing pathogens through production of antimicrobial compounds, competing for pathogen binding and receptor sites as well as for available nutrients and growth factors, stimulating immunomodulatory cells, and producing lactase. Recent scientific investigation has supported the important role of probiotics as a part of a healthy diet for human as well as for animals and may be an avenue to provide a safe, cost effective, and 'natural' approach that adds a barrier against microbial infection. There are more evidence for the use of Probiotic as therapeutic substance for the treatment of different disorders like gastrointestinal infections, allergy, inflammatory bowel syndrome, pouchitis, Ulcerative Colitis, Crohn’s disease, diarrhea, Colon cancer, etc., with dairy and non- dairy products. Probiotic not only beneficiary for humans, it is also used for animal health.

KEYWORDS: Probiotics, Gastrointestinal tract, lactic acid, therapeutic agent.

1. INTRODUCTION

The gastrointestinal tract of human, at different site is habited by beneficial bacteria. These bacteria have a relationship of symbiosis with the host. There are sites where the potentially beneficial micro-organisms are more in number than potentially harmful bacteria. This type of ecosystem composition is called Normobiosis. The environment where the potentially harmful bacteria dominate over health beneficial bacteria is called dysbiosis. The potentially beneficial bacteria are called probiotics. Probiotics term derived from Greek word “pro” (promoting) and “bios” (live). The word probiotics was introduced by Parker (1974). The term probiotic refers to live microorganisms that survive passage through by improving its intestinal microbial balance. Recently, UNFAO/WHO has defined probiotics as “living microorganisms that when administered in adequate amounts confer a health benefit on the host”.

Fig 1: Probiotics.

For probiotic products to be identified as functioning, its concentration must be at least 106 viable cells (colony forming unit, CFU/g) of the product. For at least the past 10 years, probiotic microorganisms have been used continuously for health benefits in both humans and animals. The main reason for their use is that probiotics

offer an alternative to antibiotics; such an alternative is proposed to decrease the drug resistance that occurs due to an overuse or prolonged use of antibiotics to treat infections in both humans and animals. When humans consume the contaminated foods, the drug accumulates in the body and leads to drug resistance when anantibiotic is used to treat an infection. Gut microflora can also be balanced by directly adding live microorganisms into the diet.

2. HISTORY OF PROBIOTICS

The original observation of the positive role of some bacteria can be credited to the pioneering work of Metchnikoff in the early 1900s. Almost a century ago, Metchnikoff noticed that Bulgarian peasants had an average life-span of 87 years, while approximately 4 % of such population was able to reach 100 or more years of age. One of the major differences in their lifestyle in comparison with the contemporary diet was a large consumption of fermented milk. This fact is related to the large consumption of bacteria contained in fermented milks used as a way to replacing harmful bacteria with useful ones. The term probiotic means "for life" and was created in the 1950s by Kollath. The first generally accepted definition was given by Fuller in 1992: a probiotic is "a live microbial feed supplement which beneficially affects the host by improving its intestinal microbiota balance". This definition was restricted to probiotics in animal nutrition. Actually, probiotics can defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. In 1994, the World Health Organization deemed probiotics to be the next-most important immune defence system when commonly prescribed antibiotics are rendered useless by antibiotic resistance. The use of probiotics in antibiotic resistance is termed as a microbial interference therapy.

A growing attention in both basic research on the effect of probiotics in human health and the commercial advantages of the probiotic food concept has been observed in the last 30 years. This increased research has resulted in significant advances in the understanding of the fundamental mechanisms by which probiotics may confer beneficial effects to the host. Therefore, nowadays specific probiotic microorganisms are well characterized, allowing for the verification of their attributed health benefits. The development of probiotic foods in the last two decades certainly represents an important advance in the food industry.

The global market of probiotic ingredients, supplements and foods was worth $14.9 billion in 2007 and it was expected to reach 15.9 billion in 2008, and 19.6 billion in 2013, representing a compound annual growth rate of 4.3%.

3. ABOUT PROBIOTICS

3.1. Definitions

- A **probiotic** is defined as a feasible microbial dietetic supplement that benefits the host through its effects in the intestinal tract and this definition, however, was primarily intended for use with animal feed products. For human diet, probiotics are defined as "live microbial food supplements or components of bacteria which have beneficial effects on human health".
- A **prebiotic** is defined as "as non-absorbable food materials that beneficially arouse one or more gut-beneficial microbe groups and it have a positive effect on human health". The most commonly used prebiotics are carbohydrate substances like dietary fiber with the capability to promote the components of the normal intestinal microflora which may exhibit a health benefit to the host.
- **Symbiotic** is the word coined for the mutual administration of precise prebiotics with probiotics to provide sure health benefits by synergistic action.

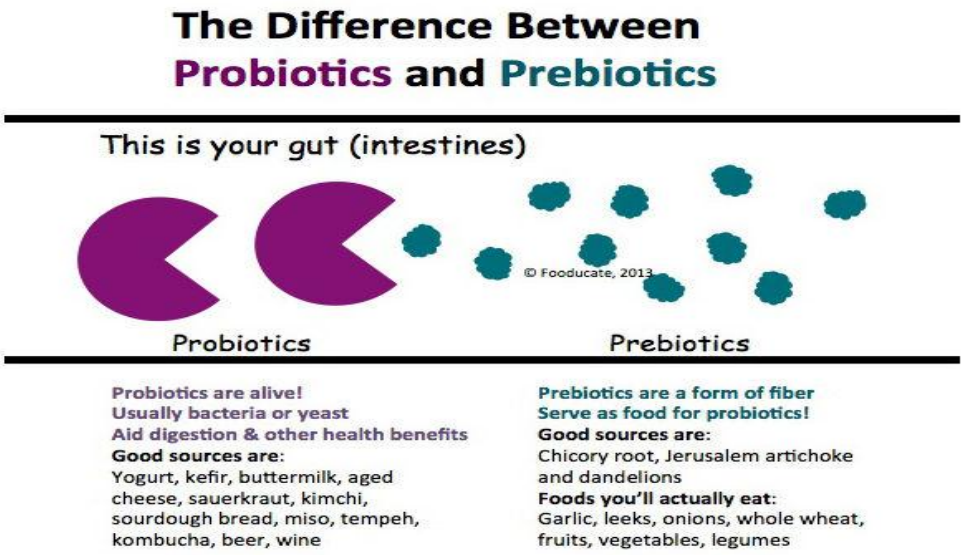

Fig 2: Difference between Probiotics and Prebiotics.

3.2. Ideal Properties of Probiotics

An effective probiotic should:

1. Exert a beneficial effect on the host.
2. Be non-pathogenic and non-toxic.
3. Contain a large number of viable cells.
4. Be capable of surviving and metabolizing in the gut.
5. Remain viable during storage and use.
6. Have good sensory properties.
7. Be isolated from the same species as its intended host.

3.3. Criteria for classifying a microorganism as a probiotic

1. It must be of human origin.
2. Have non- pathogenic properties.
3. Resistance to technological processes (i.e. viability in delivery vehicle).
4. Stability in acid and bile.
5. Adhesion to target epithelial tissue.
6. Ability to persist within the gastrointestinal tract.
7. Production of antimicrobial substances.
8. Ability to modulate the immune system.
9. Ability to influence metabolic activities.

4. CHARACTERISTICS OF PROBIOTICS

Certain physiological characteristics may be important for probiotics targeted toward particular applications. For example, resistance to stomach acid and pancreatic secretions such as bile and digestive enzymes would be important for probiotics needs to survive in high numbers through the small intestine. But if the target site for the probiotic is, for example, the mouth, these traits would not be relevant. It is apparent from the broad range of potential probiotic targets that what is required of a probiotic depends on the specific target function. Yet some basic criteria for probiotics can be set: namely.

1. They are nonpathogenic, nontoxic, and free of significant adverse side effects.
2. They must be shown to exert a beneficial effect on the consumer, preferably with a mechanistic explanation of how this occurred.
3. They should retain stability during the intended shelf life of the product.
4. They should contain an adequate number of viable cells to confer the health benefit.
5. Should be compatible with product format to maintain desired sensory properties.
6. They are labeled in a truthful and informative manner to the consumer.

5. BENEFITS OF PROBIOTICS

A. Immunologic benefits

1. Activate local macrophages to increase antigen presentation to B lymphocytes and increase secretory immunoglobin A (IgA) production both locally and systemically.
2. Modulate cytokine profile.
3. Induce hyporesponsiveness to blood antigens.

B. Non immunologic benefits

1. Digest food and compete for nutrients with pathogens.
2. Alter local pH to create an unfabourable local environment for pathogens.
3. Produce bacteriocins to inhibit pathogens.
4. Scavenge superoxide radicals.
5. Stimulate epithelial mucin production.
6. Enhance intestinal barrier function.
7. Complete for adhesion with pathogens.

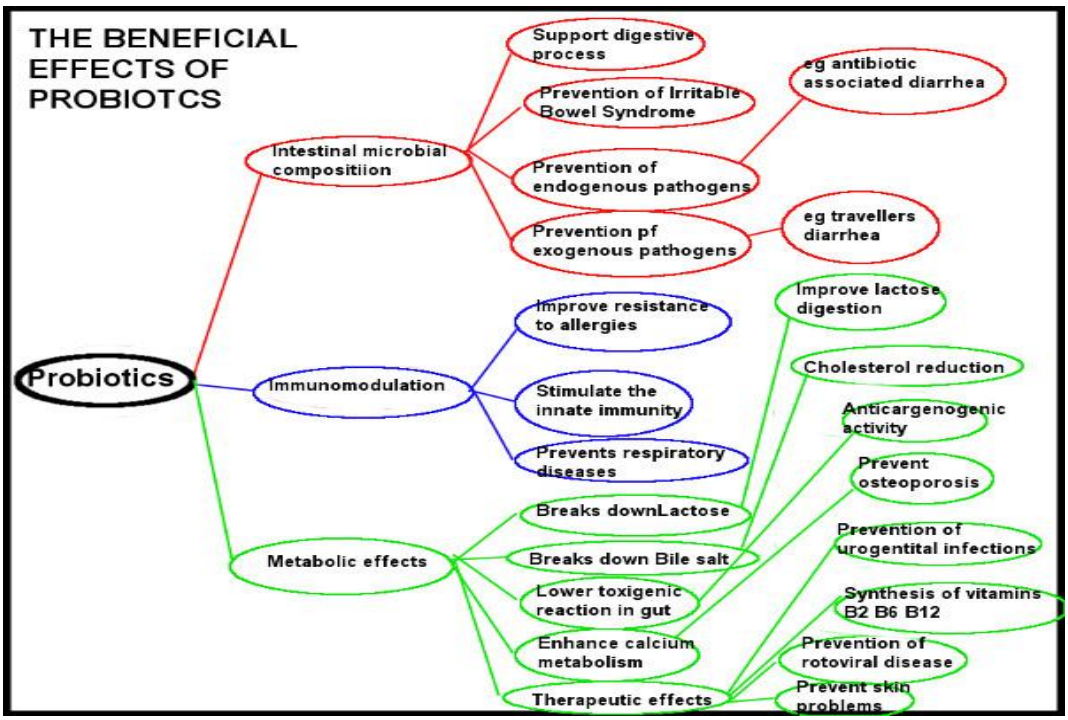

Fig 3: Overall Health Benefits of Probiotic Bacteria On Human Health.

6. SELECTION OF PROBIOTICS

Not all strains of *Lb. acidophilus*, Bifidobacterium species and *Lb. casei* are suitable for use as probiotics. The following criteria have been used or suggested for use in strain selection.

1. **Origin.** Strain should have originated from the human GI-tract.
2. **Safety.** Strain should be non-pathogenic. It should also be sensitive to common antibiotics and not harbour antibiotic resistance or virulence plasmids. Additionally I would also wish to ensure that strains that produce biogenic amines are excluded.
3. **Withstand host's natural barriers.** Essentially be able to survive transit through the GI tract. This will mean resistance to bile salts, low pH and proteases in initial in vitro screening.
4. **Adherence to intestinal epithelium.** The ability to adhere to intestinal cells and effectively block sites that could be occupied by pathogens.
5. **Commercial propagation.** Strain must be able to grow in under commercial conditions and should retain viability under normal commercial storage conditions.

7. MICRO-ORGANISMS USED AS PROBIOTICS

The following organisms as species used in probiotic preparation: Lactobacillus, Bifidobacterium, Saccharomyces, Streptococcus, Enterococcus, Bacillus and Escherichia coli. A probiotic may be made out of a single bacterial strain or it may be a consortium as well (may contain any number up to eight strains). The advantage of multiple strain preparations is that they are active against a wide range of conditions and in a wider range of animal species. Probiotics can be in powder form, liquid form, gel, paste, granules or available in the form of capsules, sachets, etc.

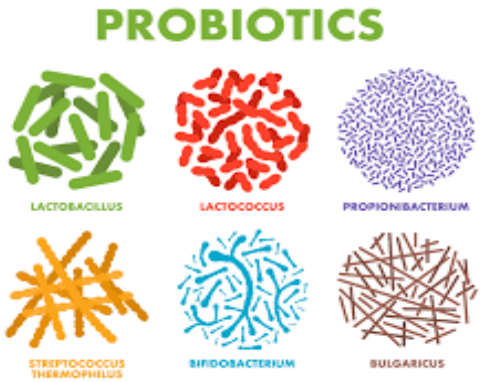

Fig 4: Micro Organisms Used As Probiotics.

There are several different kinds of probiotics, and their health benefits are determined by the job that they do in the gut. They must be identified by their genus, species, and strain level.

1. Lactobacillus: There is more than 50 species of lactobacilli. They are naturally found in the digestive, urinary, and genital systems. Foods that are fermented, like yogurt, and dietary supplements also contain these bacteria. Lactobacillus has been used for treating and preventing a wide variety of diseases and conditions. Some of the lactobacilli found in foods and supplements are **Eg:** Lactobacillus acidophilus, L. acidophilus DDS-1, Lactobacillus bulgaricus, Lactobacillus rhamnosus GG, Lactobacillus plantarium, Lactobacillus reuteri, Lactobacillus salivarius, Lactobacillus casei, Lactobacillus johnsonii, and Lactobacillus gasseri.

2. Bifidobacteria: There are approximately 30 species of bifidobacteria. They make up most of the healthy bacteria in the colon. They appear in the intestinal tract within days of birth, especially in breastfed infants and are thought to be the best marker of intestinal health. Some of the bifidobacteria used as probiotics are **Eg:** Bifidobacterium bifidum, Bifidobacterium lactis, Bifidobacterium longum, Bifidobacterium breve, Bifidobacterium infantis, Bifidobacterium thermophilum, and Bifidobacterium pseudolongum.

3. Saccharomyces boulardii: This is also known as **S. boulardii** and is the only yeast probiotic. It has shown that it is effective in preventing and treating diarrhea associated with the use of antibiotics and traveler's diarrhea. It has also been reported to prevent the reoccurrence of C difficile, to treat acne, and to reduce side effects of treatment for H. pylori.

4. Streptococcus thermophilus: This produces large quantities of the enzyme lactase, making it effective, according to some reports, in the prevention of lactose intolerance.

5. Enterococcus faecium: This is normally found in the intestinal tract of humans and animals.

6. Leuconostoc This has been used extensively in food processing throughout human history, and ingestion of foods containing live bacteria, dead bacteria, and metabolites of these microorganisms has taken place for a long time.

8. MECHANISMS OF PROBIOTIC ACTIVITY

Probiotics have various mechanisms of action although the exact manner in which they exert their effects is still not fully elucidated. Several mechanisms have been proposed to explain how probiotics work. For example, these bacteria secrete various antimicrobial substances such as organic acids, hydrogen peroxide and bacteriocins. In addition, they compete with pathogenic agents for adhesion sites on the mucosa. Probiotics can also modify the surrounding environment by modulating the pH and/or the oxidation–reduction potential, which may compromise the ability of pathogens to become established. Finally, probiotics may provide beneficial effects by stimulating nonspecific immunity and modulating the humoral and cellular immune response.

9. APPLICATION

9.1. Food Applications: The last 20 years have shown an increased interest among consumers in functional food including those containing probiotics. The presence of probiotics in commercial food products has been claimed for certain health benefits.

9.1.1. Dairy-Based Probiotic Foods: Milk and its products is good vehicle of probiotic strains due to its inherent properties and due to the fact that most milk and milk products are stored at refrigerated temperatures. Probiotics can be found in a wide variety of commercial dairy products including sour and fresh milk, yogurt, cheese, etc. Dairy products play important role in delivering probiotic bacteria to human, as these products provide a suitable environment for probiotic bacteria that support their growth and viability.

A. Drinkable fresh milk and fermented milks: Dairy products play important role in delivering probiotic bacteria to human, as these products provide a suitable environment for probiotic bacteria that support their growth and viability. Among the probiotic bacteria used in the manufacture of dairy beverages, **L. rhamnosus GG** is the most widely used.

B. Yogurt: Yogurt is one of the original sources of probiotics and is known for its nutritional value and health benefits. Yogurt is produced using a culture of L. delbrueckii subsp. bulgaricus and Streptococcus salivarius subsp. thermophilus bacteria.

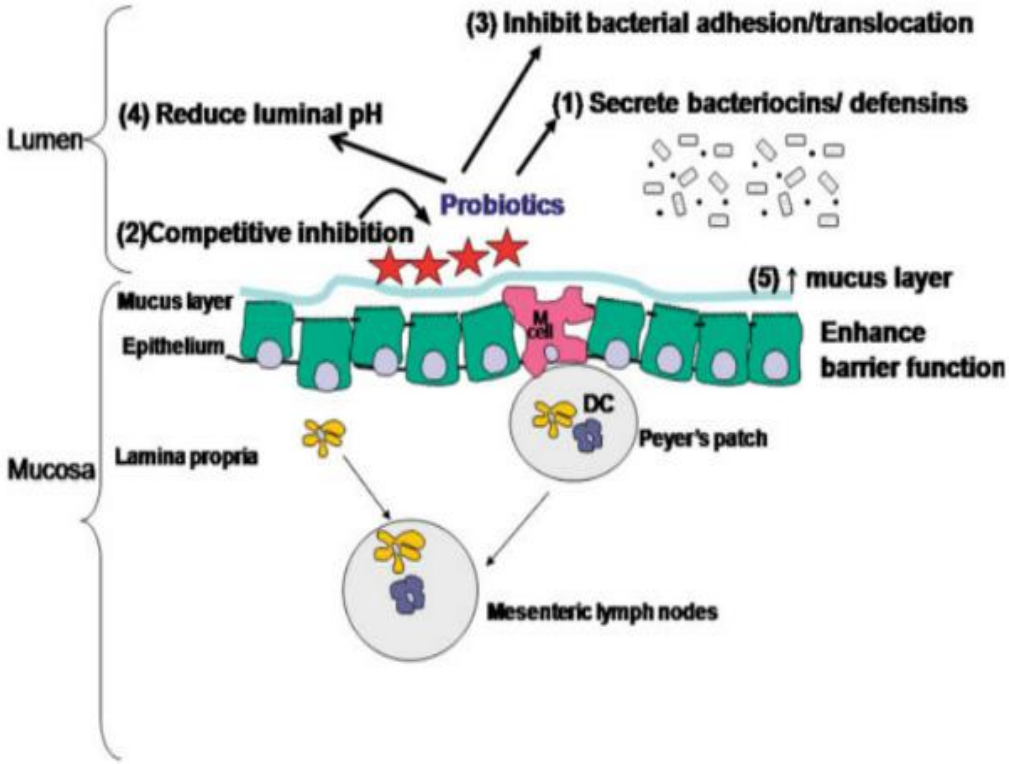

Fig 9: Yogurt.

C. Cheese: Cheeses have a number of advantages over yogurt and fermented milks because they have higher pH and buffering capacity, highly nutritious, high energy, more solid consistency, relatively higher fat content, and longer shelf life. Probiotics in cheese were found to survive the passage through the simulated human gastrointestinal tract and significantly increase the numbers of probiotic cells in the gut. However, comparing the serving size of yogurt to that of cheese, cheese needs to have higher density of probiotic cells and higher viability to provide the same health benefits. Fresh cheese like **cottage cheese** has high recommended daily intake, limited shelf life with refrigerated storage temperature. It may, thus, serve as a food with a high potential to be applied as a carrier for probiotics.

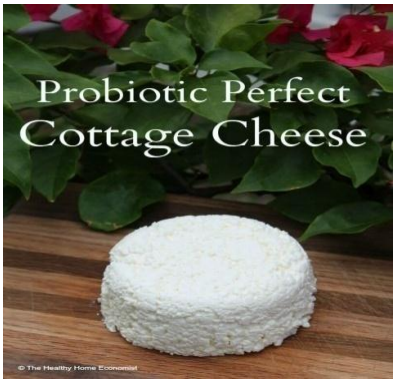

Fig 10: Cottage Cheese.

D. Other dairy based products: Other dairy products including quark, chocolate mousse, frozen fermented dairy desserts, sour cream, and ice cream can be good vehicles of probiotics. Quark was tested with two probiotic cultures to improve its nutrition characteristics and the results showed that probiotics can ensure the highest level of utilization of fat, protein, lactose, and phosphorus partially in skimmed milk. Chocolate mousse with probiotic and prebiotic ingredients were developed. Probiotic chocolate mousse was supplemented with L. paracasei subsp. paracasei LBC 82, solely or together with inulin and the results showed that chocolate mousse is good vehicle for L. paracasei. Sour cream was investigated as probiotic vehicle and the results showed that using sour cream as a probiotic carrier is proved feasible. Ice creams are among the food products with high potential for use as probiotic vehicles. Cruz and others have reviewed the technological parameters involved in the production of probiotic ice creams.

Fig 11: Other Dairy Based Products.

9.2. Agricultural applications: Probiotics applications have been extended from human applications to diversity of agricultural application. Agricultural applications include animal and plants.

A. Animal Probiotics: Probiotics have been approved to provide many benefits to the host animal and animal products production. They are used as animal feed to improve the animal health and to improve food safety with examples of the application in poultry, ruminant, pig and aquaculture. Probiotic has provided a possible natural alternative to antibiotics in poultry production to produce foods of reliable quality and safety. In addition, the application of probiotic to chicken feed was shown to increase the internal and external quality of eggs.

Applications of probiotics in aquaculture generally depend on producing antimicrobial metabolites and their ability to attach to intestinal mucus. Aeromonas hydrophila and Vibrio alginolyticus are common pathogens in fish, however, addition of probiotics strains (isolated from the clownfish, Amphiprion percula) were found capable to prevent the adhesion of these microbes to fish intestinal mucus and to compete with the pathogens.

B. Plant Probiotics: A strong growing market for plant probiotics for the use in agricultural biotechnology has been shown worldwide with an annual growth rate of approximately 10%. Based on the mode of action and effects, the plant probiotics products can be used as biofertilizers, plant strengtheners, phytostimulators, and biopesticides.

Berg has reported several advantages of using plant probiotics over chemical pesticides and fertilizers including: more safe, reduced environmental damage, less risk to human health, much more targeted activity, effective in small quantities, multiply themselves but are controlled by the plant as well as by the indigenous microbial populations, decompose more quickly than conventional chemical pesticides, reduced resistance development due to several mechanisms, and can be also used in conventional or integrated pest management systems. Probiotic bacteria can supply macronutrients and micronutrients. They metabolize root exudates and release various carbohydrates, amino acids, organic acids, and other compounds in the rhizosphere. Bacteria may contribute to plant nutrition by liberating phosphorous from organic compounds such as phytates and thus indirectly promote plant growth. Furthermore, probiotic can reduce the activity of pathogenic microorganisms through microbial antagonisms and by activating the plant to better defend itself, a phenomenon termed “induced systemic resistance”. Microbial antagonism includes the inhibition of microbial growth, competition for colonization sites and nutrients, competition for minerals, and degradation of pathogenicity factors.

10. GUT MICROBIOTA-THE SOURCE OF PROBIOTICS

The intestine's normal microflora is a metabolically active but as yet unexplored area of host defence. Major functions of the gut microbiota include metabolic activities that result in salvage of energy and absorbable nutrients, trophic effects on the intestinal epithelium and protection of the host against invasion by harmful microbes. The microbiota of a newborn develops rapidly after the birth and it is initially dependent mainly on the mother’s microbiota, mode of delivery, birth environment and rarely genetic factors. The maternal vaginal and intestinal flora constitutes the source of bacteria, which colonizes the intestine of the newborn, the dominating strains being facultative anaerobes such as the enterobacteria, coliforms and lactobacilli. After weaning, the composition of the microflora gradually alters to resemble that of the adult. It has been estimated that at least 500 different microbial species exist in the GIT although on a quantitative basis about 20 genera probably predominate. These include Bacteroides, Lactobacillus, Clostridium, Fusobacterium, Bifidobacterium, Eubacterium, Peptococcus, Peptostreptococcus, Escherichia, and Veillonella. The bacterial strains with beneficial properties include mainly bifidobacteria and lactobacilli.

10.1. Regions of the human body colonized by microbes

Bacteria are prevalent in several regions of the body, including the mouth, nose, pharynx, intestinal tract, vaginal tract, and skin. The stomach is not heavily colonized because of its low pH, and typically harbors up to $10^{[3]}$ colony forming units (CFU) per gram of contents, mainly consisting of lactobacilli, streptococci, and yeasts. In addition, Helicobacter pylori colonization of the stomach is endemic in certain geographical regions of the world. The duodenum, or first part of the small intestine, also has low microbial populations because of both the quick transit of contents through it and the presence of pancreatic secretions that create a hostile environment for microbes. There is a progressive increase in both numbers and species of microbes, however, along the jejunum and ileum, from approximately $10^{[4]}$ to $100^{[6-7]}$ CFU per gram of contents at the ileo-cecal region. The colon is the most heavily populated area of the gastrointestinal tract, with numbers typically in the region of $10^{[11]}$ CFU per gram (wet weight) of contents. This environment supports greater bacterial growth with a slower transit time, ready availability of nutrients, and favorable pH. Recently, Eckburg characterized the microbiota of feces and the intestinal lining of the colon of three healthy humans and found that the majority of microbes present were not from species that have been cultured to date. These concluded that additional research still is needed to understand fully the microecology of the intestine. In women, microbes (many of fecal origin) inhabit the vagina to a concentration of approximately $10^{[7-8]}$ CFU per milliliter (ml) of fluid, with Lactobacillus species

dominant in healthy subjects and urinary and vaginal pathogens dominant in patients with infection.

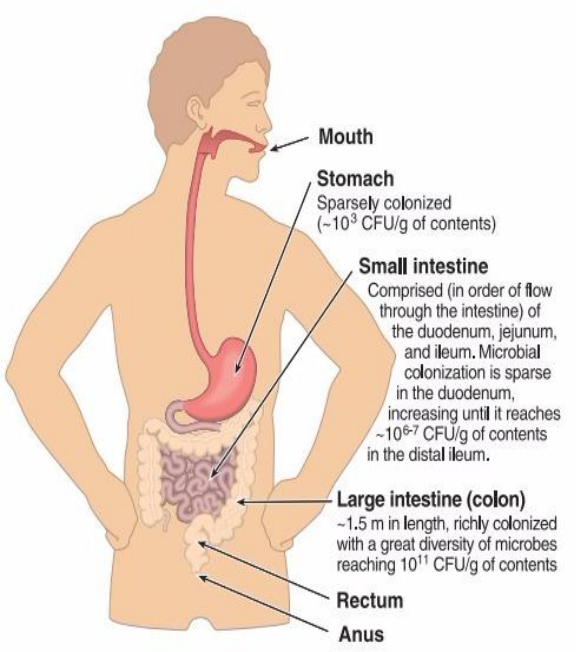

Fig 12: Human Gastrointestinal Tract.

11. PROBIOTIC IMPACT ON HUMAN HEALTH AND VARIOUS DISEASES

Studies on the impact of probiotics on human health and disease have emphasized different components of the field, such as use of probiotics in medical practice, use in pediatric populations, immunomodulation, and intestinal diseases. The following points highlight specific areas of probiotic intervention in human health and disease.

11.1. Diabetes: "Diabetes is a chronic disease that occurs when the pancreas does not produce enough insulin, or when the body cannot effectively use the insulin it produces" Diabetes mellitus is one of the most prevalent diseases in the world with the ranking of 9th with respect to number of deaths.

Diabetes management includes the use symbiotic (probiotic and prebiotics). At the Start of 20th century, it was thought that probiotics beneficially affect the host by improving balance of gut microbiota. Recent researches show that there is a connection between bacterial population in gut and metabolic disease in human (especially diabetes). Recent studies based on large-scale 16S rRNA gene sequencing, quantitative real time PCR (qPCR) and fluorescent in situ hybridization (FISH), have shown that there is a connection between the composition of the intestinal microbiota and metabolic diseases like obesity and diabetes. Danish researches worked on 36 Danish people and came to know that there is a difference in gut microbial flora of diabetic and non diabetic peoples. These men were of different age and body weight and 18 of them are diabetic and 18 are non diabetic they also found 3 types of major phyla of bacteria that reside in gut of human. These are firmicutes (most important is lactobacillus which is beneficial bacteria), proteobacteria and bactereodetes (opportunistic pathogens which can cause gum disease and tooth decay). There was a low level bacteria from phylum firmicutes and greater level of bacteria from phylum bactereodates. Researchers also found that increased level of bactereodetes and decreased level of firmicutes will lead to decreased glucose tolerance which is key problem with diabetes mellitus. Probiotics are supposed to treat the diabetic patients by balancing microbial gut flora.

Low-fat (2.5%) **dahi containing probiotics Lactobacillus acidophilus and Lactobacillus casei** was tested in rats against high fructose-induced type-2 diabetes. Both these bacteria proved beneficial effect in lowering blood glucose by decreasing insulin resistance. It is also suggested that the use of probiotics can decrease the insulin resistance and can also lower the incident of hypertensive conditions that are closely related to diabetes. It has also been found that **Bifidobacterium spp** delivers pharmaco nutritional support in treating insulin resistance. Probiotic food is yogurt Sauerkraut, miso, tempeh, kimchi, kefir.

Fig 13: Marketed Products for L. acidophilus and L. casei Strains.

11.2. Hypertension: The incidence of increased blood cholesterol has been increased in adults, children and adolescence. Most important causes of hypertension are lipid abnormality, hypercholesterolemia and obesity. Mann and Spoerry were among the first to illustrate that lactobacillus-fermented milk has hypocholestrolemic effects. New researches have shown that not only the Lactobacilli exhibit hypocholesterolemic effects, but Bifidobacteria could also cause a significant reduction in serum cholesterol when cholesterol is elevated. As we know that most of the cholesterol is synthesized and absorbed in intestine, therefore intestinal micro flora has shown to effect cholesterol level in blood. Studies have shown that probiotics have been proved beneficial in lowering hypertension by decreasing blood cholesterol level and increasing resistance of LDL to oxidation.

A group of scientist performed a randomized, crossover, and placebocontrolled design trial consisting 29 women to test the hypocholesterolemic effect of yoghurt containing L. acidophilus and B. longum. This cross over study was performed to 21 weeks duration and involved the administration of 300g/day yogurt. The result of the study showed that HDL increased significantly. The important factor is rennin-angiotensin system (RAS) which regulate blood pressure. Angiotensin converting enzyme (ACE) regulates this pathway. There are some probiotics which upon fermentation produces proteinases capable of producing ACE inhibitory peptides. And thus regulate blood pressure. Several studies have demonstrated that Lactobacillus helveticus are involved in producing antihypertensive peptides which are ACE inhibitory tripeptides Val-Pro-Pro (VPP) and IlePro-Pro (IPP) from milk protein casein.

Fig 14: Marketed Products for L. acidophilus and B. longum Strains.

11.3. Periodontal Diseases

Periodental disease is an inflammatory disease which effect one or more periodontal tissues like alveolar bone, periodontal ligament, cementum, and gingiva.

It is discovered that culture supernatant of L. acidophilus, when used in persons suffering from periodontal diseases (gingivitis, periodontitis and pregnancy gingivitis), treats most of the periodontal diseases. The probiotic species treating gingivitis include L. brevis, L. casei, L. salivarius, reuteri strains, Bacillus subtilis, L. reuteri and L. brevis. L. brevis was found to contain anti inflammatory activity and it also inhibit MMP (collaginase) activity. B. subtilis showed encouraging result in periodontitis by decreasing the number of pathogens in periodontal tissues.

11.4. Halitosis or Bad Breath

Halitosis has many causes (including consumption of particular foods, metabolic disorders, respiratory tract infections), but in most cases it is associated with an imbalance of the commensal microflora of the oral cavity. More specifically, halitosis results from the action of anaerobic bacteria that degrade salivary and food proteins to generate amino acids, which are in turn transformed into volatile sulphur compounds, including hydrogen sulphide and methanethiol. Kang and colleagues reported the capacity of various strains of W cibaria to inhibit the production of volatile sulphur compounds by F nucleatum. They concluded that this beneficial effect resulted from the production of hydrogen peroxide by W cibaria, which inhibited the proliferation of F nucleatum. A recent study showed that certain bacterial species, including Atopobium parvulum, Eubacterium sulci and Solobacterium moorei, predominate on the dorsal surface of the tongue among people with halitosis. Conversely, another species, Streptococcus salivarius, was detected most frequently among people without halitosis and is therefore considered a commensal probiotic of the oral cavity. S salivarius is known to produce bacteriocins, which could contribute to reducing the number bacteria that produce volatile sulphur compounds. The use of gum or lozenges containing S salivarius K12 (BLIS Technologies Ltd., Dunedin, New Zealand) reduced levels of volatile sulphur compounds among patients diagnosed with halitosis.

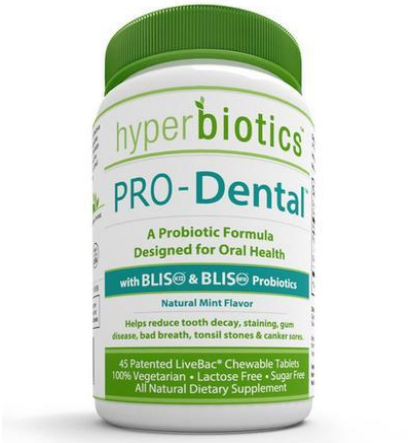

Fig. 15: Marketed Products for S. salivarius Strain.

12. CONCLUSION

There is scientific evidence supporting the incorporation of probiotics in nutrition as a means of derivation of health benefits. This evidence seems adequate concerning the prevention and treatment of certain conditions while simply promising or even controversial when it comes to others. The best documented effects include bowel disorders such as lactose intolerance, antibiotic-associated diarrhoea and infectious diarrhoea, and allergy, and emerging evidence accumulates concerning their potential role in various other conditions. In the same time as relevant consumer awareness grows, such products are becoming increasingly popular and tend to represent one of the largest functional food markets. Dairy products, particularly yoghurt, continue to be the most important vehicles for delivery of probiotic bacteria to the consumer with the nondairy sector continuously evolving as well, as a result of food technology advances and the growing demand. A virtuous circle is therefore created: as the range of new products with improved sensory appeal widens, consumer acceptance increases and the food industry invests more on this growing market by development of new processes and products. Nevertheless, the development of probiotics for human consumption is still in its infancy. Further research, in the form of controlled human studies, is needed to determine which probiotics and which dosages are associated with the greatest efficacy and for which patients, as well as to demonstrate their safety and limitations. In addition, the regulatory status of probiotics as food components needs to be established on an international level with emphasis on efficacy, safety, and validation of health claims on food labels. There is no doubt that we will witness a significant increase in the role of probiotics in nutrition and medicine over the next decade and while their application in the prevention and treatment of various disorders should be considered by medical professionals and promoted by the food industry, this should be done with skepticism and respect to the consumer.

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