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The Use of Probiotics in Prevention and Treatment of Diseases

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Abstract:
Probiotics are live microorganisms that when administered on man in adequate amount can help to prevent and treat various diseases. Advances in probiotic research have confirmed the health benefits of some bacterial strains used as probiotics. The main strains used which include lactic acid bacteria and bifidobacteria that inhabit the intestinal tracts. The activities of probiotics were discussed, which include food digestion, production of useful products to destroy pathogenic organisms, and to complement the functions of missed digestive enzymes. The paper listed the organisms used as probiotics as belonging to three classes of bacteria which are Lactobacilli, Bifidobacterium and Enterococci. The mechanism by which probiotics work which include competing for dietary ingredients as growth substrate of pathogens, bioconversion of some food substrate to products that has inhibitory properties, production of growth substrate like vitamins for the normal intestinal microbes, production of bacteriocin that give direct antagonism to pathogenic microbes, competitive exclusion for binding sites of pathogens and stimulation of innate immune response among others were discussed. The use of probiotics for treatment or prevention lactose maldigetion, Irritable Bowel Syndrome (IBS), Inflamatory Bowel Diseases (IBD), colon cancer, hepatic diseases, hyperlipidemia diarrhea, vaginal infection, obesity and diabetes and its use in stimulation of mucin and maintaining of gut integrity in prevention of diseases were stated. In conclusion foods such as Sweet acidophilus milk, Ice cream, Low cheddar cheese, Whey drink, Natural –set yogurt, Yogurt and Soy milk have been observed to serve as carrier of probiotics.

Keywords: *Dietary, diseases, enzymes, pathogens, probiotics*

1. Introduction

There are numerous groups of microbes collectively working in human body to perform various functions (Amara and Shibl, 2015). Microbes have associated with various roles which include causing of diseases and some with beneficial functions such as production of fermented foods, like dairy products, bread, wines, vegetables and other numerous activities. (Fioranmonti et al.,2003).

Microbes in human guts perform various beneficial responsibilities which include helping to supplement for deficiencies of digestive systems by reducing the steps required to change complex food substances to simpler ones the body can absorb. There are some other types which compete with these beneficial ones and bring about improper digestion and can add toxins to food during digestive processes (Amara, 2012). Sullivan et al (1992) stated that most of the bacteria found in human body have the gut as their habitat and the intestinal microbiota have metabolic functions such as fermenting indigestible dietary residue and endogenous mucus, saving energy, production of vitamin K and absorption of ions.

Gut microbes are either commensals (native colonizing) or transient (microbes passing through) which can be beneficial, potentially harmful or pathogenic. Beneficial microbes help the body through interaction with the host immune system and also serve as competitive inhibitors of pathogens; they also ferment carbohydrates without producing toxins. Microbes not habitual residents of the gut can be introduced into the gut as probiotics to influence the actions of the gut microbes (Sullivan et al., 1992).

FAO/WHO (2002) defined probiotics as live microorganisms which when administered in adequate amount confer health benefits on the host. Probiotics are considered as living microbes that can be administered into the intestinal bionetwork in adequate number to perform effect positive health effects (Gismondo et al.,1999).

Ishibashi and Yamazaki (2001) defined probiotics as a food (feed) or drug containing live microbes that when ingested, is expected to confer beneficial physiological effect on the host animal through microbial action. It is essential to note that microbial components and metabolites are not included in the definition of probiotics. Food and Agricultural Organisation (FAO/WHO, 2001), and the International Scientific Association for Probiotics (Reid et al., 2003) defined probiotics as live microorganisms which when administered in adequate amount confer a health benefits on the host.

1.1. Origin of Probiotics

Nobel Prize winning Russian scientist Llya Metchnikoff was of the view that food borne bacteria can be beneficial to health and he hypothesized that consuming consumption of large amount of fermented milk products containing Lactobacillus bacteria (''soured milk'') could prolong and improve the quality of life because these bacteria entered the colon and limited the activities of pathogenic bacteria (Nino Binns, 2013).

Probiotics existed in our traditional foods such as beverages, salted fish, yogurt and cheese since old time and are not new invention. Man has been producing different types of food by fermentation to preserve the food or give another taste and microbes were been used to ferment such foods (Amara, 2012).

1.2. Common Microbes Used as Probiotics

Amara and Shibl (2013) stated that microbes used as probiotics are of different types ranging from bacteria to yeast or mold. Norio and Shoji (2001) stated that among the numerous intestinal microbes, those that are beneficial to man affect the host by improving the intestinal microbial balance, and hence are selected as probiotics. They include species of the genera Lactobacillus, Bifidobacterium and Enterococcus. The various species are:

Lactobacillus johnsonii, L. gasseri, L. casei, L. rhamnosus, L. plantarum, L. sporogenes, L. delbrueck, L. reuteri, L. fermentum, L. lactus, L. cellobiosus, L. brevis, L. forcimims, L. paracasei, L. cripatus.

Bifidobacterium bifidum, B. foecium, B. longum, B. infatis, B. foecalis, B. adolescentis, B. thermophiles, B. animalis, B. breve, Streptococcus lactis, S. cremoris, S. alivarius, S. intermedius, S. thermophilis and S. diocetylactis.

Yeast and molds also include: Saccharomyces cerevisae, Saccharomyces bourladii, Aspergillus niger, Aspergillus oryzae and Candida pintolopessi.

The purpose of this work is to review works on various microorganisms whose activities are associated with diseases prevention and treatment with a view to encourage further research into probiotics and their utilization.

1.3. Criteria for Selection of Probiotics

Some factors must be put into consideration for a microbe to be suitable to serve as probiotics and these factors include

- It must be able to survive the environment condition of their passage to the site of action. Considering probiotics targeted for actions in the colon, it must resist salivary enzymes, stomach acid, bile secretion of small intestine, temperature and pH change in the gut.
- It must be able to withstand competition with the native colonising microbes
- It must be culturable on large scale
- It must be genetically stable
- It must be able to maintain viability in food products or supplements. (Council for Agricultural Science and Technology, 2007)

Safety is a major factor that must be addressed in selection of microbes for probiotics and evaluation of microbes for safety include pathogenicity, infectivity and virulence factors which comprise toxicity, metabolic activity and its intrinsic properties (Ishibashi and Shoji, 2001). Ishibashi and Yamazaki (2001) observed that safety of bacteria strains may be evaluated by considering whether the invasion of the host by the probiotic bacteria leads to infection? Are the infection results severe on the host? Do these bacteria produce toxic substance as result of metabolic activities?

1.4. Probiotics in Diseases Prevention and Treatment

According to Amara and Shibl (2013) summary of relation of probiotics to our health is stated as follows:

- Probiotics are friendly and useful microbes
- They have ability to compete with pathogenic microbes and colonise digestive system of the host
- They are useful in fermentation of food to simpler by-products and promote by many different mechanisms.
- They are taken orally because their amount could deteriorate due to factors like incorrect diets, alcohol consumption, and age and so on.
- Taken as food or orally after use of antibiotics which are expected could affect the population severely will help them to re colonise the gut.
- Probiotics also promote health through the following processes too

➢ Removal of side effect of pathogen of harmful microbes
➢ Supply of useful by-products to the body
➢ Help to reduce the process of digestion hence helping the digestive system
➢ Their biofilm reduce the effect of first attack of harmful compounds because it covers the cell from direct contact with the harmful substance.
➢ Reduction of amount of food needed by body due to correct digestion and metabolism
➢ Probiotics in some cases, could complement the deficiency in host genetic material by helping the body produce products of their gene the body is deficient in producing(example is the case of the Lactose fermentation deficiency).

In 1994, the World Health Organisation declared probiotics to be next-most important immune defence system when commonly prescribed antibiotics are rendered useless by antibiotics resistance (Kallasapathy and Chin, 2000; Levy, 2000). Amara and Shibi (2003), reported the different types of probiotics microbial strains and their usage.
This is shown in Table 1 below.

Disease Name	Strain	References
Eczema	Escherichia coli Bifidobacterium bifidum Bifidobacterium lactis Lactococcus lactis	Niers et al., 2009; Soh et al., 2009; Viljamen et al., 2005a and Viljamen et al., 2005b.
Food allergies	Escherichia coli	Lodinova-Zadnikova et al., 2003
Immunity	Bacillus circulans PB7 Lactobacillus plantarum DSMZ 12028	Bandyopadhyay and Das Mohapatra (2009) and Cammarota et al., (2009)
Antibiotic effect removal	Enterococcus mundtii ST4SA Lactobacillus plantarum 423 Lactobacillus brevis KB290 Lactobacillus strains Bifidobacterium strains	Botes et al., 2008; Fukao et al., 2009 and Zhou et al., 2005
Gastroenteritis Therapeutics	Lactobacillus casei	Yamada et al., (2009)
Intestinal hyperpermeability	Lactobacillus plantarum species 299 (LP299)	Kennedy et al., 2000; Strowski and Wiedenmann, 2009 and White et al., 2006
Vaginal candidiasis (thrush)	Lactobacillus rhamnosus GR-1 Lactobacillus reuteri RC-14	Martinez et al., (2009)
Urinary tract infection	Lactobacillus rhamnosus GR-1 Lactobacillus reuteri RC-14	Anukam et al., (2009)
Lactose intolerance	Lactobacillus acidophulus	Hawrelak (2003)
Non-steroidal anti-inflammatory drug	Escherichia coli strain Nissle 1917	Ukena et al., (2005)
Intestinal dysbiosis	Lactobacillus johnsonii La1 Lactobacillus strain Lactobacillus GG	Hawrelak, 2003; Silva et al., 1987, and Bennett et al., (1996)
Irritable bowel syndrome	Bifidobacterium infantis 35624 Escherichia coli DSM17252 Bifidobacterium infantis 35624	Brenner and Chey, 2009; Enck et al., 2009 and Whorwell et al., 2006
Traveler's diarrhea	Lactobacillus GG Lactobacillus plantarum	Hawrelak, (2003); Michail and Abenathy, (2002)
Radiation-induced diarrhea Crohn's disease	Lactobacillus casei DN-114 001 Escherichia coli strain Nissle 1917	Giralt et al., (2008) Boudeau et al., (2003)
Prevention of colon cancer	Enterococcus faecium M-74 lactic acid bacteria	Mego et al., 2005 and Thirabunyanon et al., 2009
Ulcerative colitis	Lactobacillus acidophilus Escherichia coli strain Nissle 1917 Bifidobacterium	Abdin and Saeid, 2008; Adam et al., 2006 and Imaoka et al., 2008
Peptic ulcer disease	Lactobacillus acidophulus	Iarovenko et al., (2007)
Prevention of atopy	Lactobacillus rhamnosus GG	Huure et al., 2008 and Van der Aa et al., 2008
Hypercholesterolemia and cardiovascular diseases	Enterococcus faecium M-74 Lactobacillus plantarum Pro-pionibacterium freudenreichii Lactobacillus plantarum PH04	Hlivak et al., 2005; Kiatpapan et al., 2001 and Nguyen et al., 2007.

Table 1: Different Types of Probiotic Microbial Strains and Their Usage
Source: Amara and Shibl, 2013

2. Probiotics in Diseases Prevention and Treatment

2.1. Enhancement of Epithelial Barrier and Maintaining Gut Integrity

According to Bermudez-Brito et al (2012), the major mechanism action of probiotics include the enhancement of epithelial barrier of the gut, increasing adhesion to intestinal mucosa and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microbial substances and modulation of the immune system

The major defense mechanism used to maintain epithelial integrity and protect the enteric flora from the environment is the intestinal barrier which is permanent contact with the luminal content and the dynamic enteric flora. The defenses of the intestinal barrier include mucous layer, antimicrobial peptides, secretory IgA and the epithelial junction adhesion complex (Ohland and Macnaughton, 2010). Hooper et al (2003) and Sartor (2006) stated that disruption of this barrier function allows bacterial and food antigens to reach the submucosa and can induce inflammatory responses which may result in intestinal disorders such as inflammatory bowel disease. Consumption of non-pathogenic bacteria (probiotic bacteria) has been extensively studied to show their contribution to intestinal barrier function and involvement in maintenance of the barrier. (Bermudez-Brito et al., 2012). Eschricia coli Nissile 1917 (EcN1917) prevents the disruption of the mucosal barrier by enteropathogenic E.coli at the same time has ability to restore mucosal integrity in T84 and Caco-2 cells (Stetinova et al., 2010)

Mucin glycoprotein (mucins), a major macromolecular constituents of epithelial mucus which has been implicated in health and diseases is been produced by probiotics especially Lactobacillus species and they help to promote mucous secretions as a mechanism that improves barrier functions and exclusion of pathogen (Mattar et al.,2002, Kim et al., 2008).

2.2. Antimicrobial Properties

Probiotics act as antimicrobial by secreting the products called bacteriocin and substances such organic acids which include lactic acid, acetic acid and butyric acid likewise hydrogen peroxide (De Keersmaecker et al., 2006). According to Napgal et al (2012) production of antibiotic materials gives probiotics ability to establish their presence in gastrointestinal tract (GIT) and eliminate competitors. Lactobacillus acidophilus has been shown to produce bacteriocin lactacin B and acidolin that have shown to exhibit inhibition against Lactobacilli in-vitro and enteropathogenic organisms are also inhibited by acidolin. These products also lower also agglutinates pathogenic microbes, bind and metabolise toxic metabolites that can cause illness in the host (Fonden et al., 2000; Haskard et al., 2001; Oatley et al., 2000).

2.3. Anticarcinogenic Properties

Kumal et al (2011) stated that probiotics that can inhibit actions of intestinal bacterial enzymes that covert procarcinogens to more proximal carcinogens are possible to have anti-cancer effects. Consumption of contaminated food containing Aflatoxin has been established to cause liver cancer and some probiotic bacterial strains have been successfully shown to bind and neutralize AFB1 in vivo consequently reducing bioabsorption of the toxic from the gut (Haskard et al., 2000; Kumar et al., 2011). Li and Li (2003) has shown that oral administration of LAB on rat effectively reduce DNA damage induced by chemical carcinogens in gastric and colonic mucosa of rats.

Probiotics have also been found by several researchers to decrease faecal concentration of enzymes (glycosidases, B-glucuronidase, azoreductase and nitroreductase) and secondary bile salts and also reduce the absorption of harmful mutagens that may contribute to colon carcinogenesis (Rafter, 1995). According to Pedrosa et al. (1995), normal intestinal flora can influence carcinogenesis by producing enzymes like glycosidases, B-glucuronidase, azoreductase and nitroreductase that transform precarcinogens into active carcinogens. Lactobacillus acidophilus and L. casei supplementation in humans help to decrease the levels of these enzymes (Lidbeck et al., 1991). According to Hirayama and Rafter (2000) and Kumar et al (2011), several mechanisms on how lactic acid bacteria may inhibit colon cancer have been proposed. These include enhancing the host's immune response, altering the metabolic activity of the intestinal microbial communities, binding and degrading carcinogens, producing antimutagenic compounds and altering the physiochemical conditions in the colon. Li and Li (2003) have shown that oral administration of LAB on rat effectively reduces DNA damage, induced by chemical carcinogens in gastric and colonic mucosa of rats.

2.4. Immunogenic Enhancement

Gomez-Llorente et al (2010) stated that probiotic bacteria can exert an immunomodulatory effect because they have ability to interact with epithelial and dendritic cells (DCs). There have been several reports indicating that Lactobacilli used in dairy products can enhance the immune response of the host. Organisms that have been identified having this property are Bifidobacteriun longum, Lactobacillus acidophilus, Lactobacillus casei rhamnosus and Lactobacillus helveticus (Isolauri, 2001). Autorri et al. (2002) observed increase in lymphocytes proliferation in the spleen, peripheral blood and Peyer's patches of rats fed with yogurt containing L. bulgaricus 100158 and S. thermophiles 001158. Gills and Rutherfurd (2001) are of the opinion that consumption of probiotics by elderly will be of great use to enhance their immunity because immune functions declines with age. Regardless of the mechanism involve, probiotics culture have been shown to stimulate both non-specific and specific immunity (Nagpal, et al, 2012).

2.5. Lactose Maldigestion

Lactose is a sugar which splits into glucose and galactose. The enzyme lactase is responsible for splitting of lactose into glucose and galatose. Lactose is sugar found in milk. The enzyme lactase is produce by infants and children, but most adults stop producing lactase as adults. When these adults consume dairy products with lactose, they can develop gastrointestinal symptoms such as abdominal bloating, pains, flatulence and diarrhea. This situation is found in 5 to 15% of adults in Northern European and American countries and in 50 to greater than 90% of adults in Africa, Asia, and South American countries (de Vrese et al., 2001). People with this deficiency eliminate milk and dairy products from their diet and consequently their calcium intake may be compromised (CAST, 2007). The bacteria used as starter culture in yogurt (Streptococcus thermophiles and Lactobacillus delbbrueckii subsp. Bulgaricus) also produce lactase, and when consumed with dairy products can improve digestion and symptoms in these individuals (Kolars, et al., 1984).

A similar benefit was identified in infants with sucrose deficiency, which cause diarrhea from sucrose ingestion. Enhanced digestion of sucrose was demonstrated when Saccharomyces cerevisae a yeast, containing enzyme sucrase was administered therapeutically (Alternative Medicine Review, 2003).

2.6. Irritable Bowel Syndrome (IBS)

Probiotics exhibit a direct effect in the gut in treatment of inflammatory and functional bowel disorder (Alternative Medicine Review, 2003). Symptoms like abdominal pains, bloating, and flatulence commonly occur in patient with IBS. Some leftover food not digested that reached the colon are processed by some gut bacteria without producing gas while some consumed the gas produced particularly hydrogen. Nevertheless, some produce gas, which is eliminated from body by flatulence.

In a double-blind, clinical trial of 48 patients with bloating-predominant IBS, the probiotics mixture VSL #3 decreases flatulence scores (Kim et al., 2005).

O'Mahomy et al. (2005) stated that two large studies in adults showed that either Bifidobacterium infatis 35624 or a strain mixture (Lactobacillus rhamnosum GG, Lactobacillus rhamnosum LC 705, Bifidobacterium breve Bb99 and Propionibacterium freudenreichii subsp Shermanii JS) can be effective in alleviating symptoms of IBS.

2.7. Diarrhoea

A number of clinical trials have tested the efficacy of probiotics in the prevention of acute diarrhea, including antibiotic-associated diarrhea. Probiotics given along with antibiotics therapy have been shown to decrease the incidence of antibiotic-associated diarrhea in children and in adults (CAST Issue Paper, 2007). Different strains have been tested including Lactobacillus rhamnosus GG, the yeast Saccharomyces cerevisae (baulardii) Lyo and undefined strains of Lactobacillus acidophilus and Lactobacillus delbruekii subsp. Bulgaricus. Meta-analysis of controlled trial concluded that probiotics, particularly Lactobacillus rhamnosus GG and Saccharamyces cerevisae (boulardii) Lyo, can be used to prevent antibiotic-associated diarrhea (McFarland, 2006; Sazawae et al., 2006).

Prophylactic use of probiotics has proved useful for prevention of acute diarrhea in infants admitted to hospitals with chronic diseases (CAST Issue Paper, 2007). According to Saavedra et al (1994), the supplementation of an infant formula with Bifidobacterium animalis Bb 12 and Streptococcus thermophiles TH4 significantly decreases the incidence of diarrhea in hospitalised infants aged 5 to 24 months.

2.8. Probiotics in Diabetes and Obesity

The role of gut flora in the pathology of insulin resistance (type 2 diabetes) and obesity has been well documented (Ley et al., 2005). Animal and human studies have suggested that gut flora enhances the body weight gain and increases the insulin resistance, and these phenotypes are transmittable with gut flora during the implantation studies of microbiota from obese to normal and germ-free mice (Ley et al., 2006; Turnbaugh et al., 2006). The mechanisms associated with gut flora—mediated pathology of obesity and diabetes are through (1) increased energy harvest, (2) increased blood LPS levels (endotoxemia), and (3) low-grade inflammation (Delzenne et al., 2011). Therefore, modulation of gut flora has been considered as a potential target to treat against obesity and diabetes and its complication through enhancing antioxidant system (Yadav et al., 2008). Bifidobacteria, one of the important classes of probiotic organisms have been found decreased in overweight women in comparison with normal weight women (Santacruz et al., 2009). Aronsson et al. (2010) suggested that probiotic-based selective strain of Lactobacilli and Bifidobacteria showed beneficial effect on obesity and type-2 diabetes. Andereasen et al, (2010) reported that L. acidophilus decreased the insulin resistance and inflammatory markers in human subjects. An et al. (2011) Vajro et al. (2011) and Kang et al. (2010) showed that feeding of specific strains of Lactobacilli and Bifidobacteria ameliorate the progression of obesity and diabetes suggesting that probiotic-mediated modulation of gut flora can be a potential therapy against obesity and diabetes.

3. Mechanism of Actions of Probiotics

Probiotic bacteria have multiple and diverse influences on the host. Different organisms can influence the intestinal luminal environment, epithelial and mucosal barrier function, and the mucosal immune system. The numerous cell types affected by probiotics involve epithelial cells, dendritic cells, monocytes/macrophages, B cells, T cells. There are significant differences between probiotic bacterial genera and species. These differences may be due to various mechanism of action of probiotics. It is crucial that each strain be tested on its own or in products designed for a specific function. Molecular research on these probiotics pays attention to these strain-specific properties. Different probiotic strains have been associated with different effects related to their specific capacities to express particular surface molecules or to secrete proteins and metabolites directly interacting with host cells (Nagpal et al., 2012).

The effectiveness of probiotics is related to their ability to survive in the acidic and alkaline environment of gut as well as their ability to adhere and colonize the colon. The mechanisms for the improved mucosal barrier are achieved by providing a means of limiting access, with respect to pH, redox potential, hydrogen sulphide production, and antimicrobial compounds/molecules, to enteric pathogens or by several interrelated system such as mucous secretion, chloride and water secretion, and binding together of epithelial cells. Hydrogen peroxide in combination with lactoperoxidase—thiocyanate milk system exerts a bactericidal effect on most pathogens (Kailasapathy and Chin, 2000). Bacillus clausii constitute < 1% of gut microbial communities, stimulate CD4 proliferation, and produce bacteriocins to limit the growth of potential pathogens. Microbial communities also enhance nutritive value by producing several enzymes for the fermentation of non-digestible dietary residue and endogenously secreted mucus (Roberfroid et al., 1995) and help in recovering lost energy in form of short-chain fatty acids. They also have a role in the synthesis of vitamins (Conly et al., 1994) and in the absorption of calcium, magnesium, and iron (Younes et al., 2001). The figure below shows various mechanisms used by probiotics. Some health benefits of probiotics and their mechanisms are illustrated in Figure 1 and Table 2.

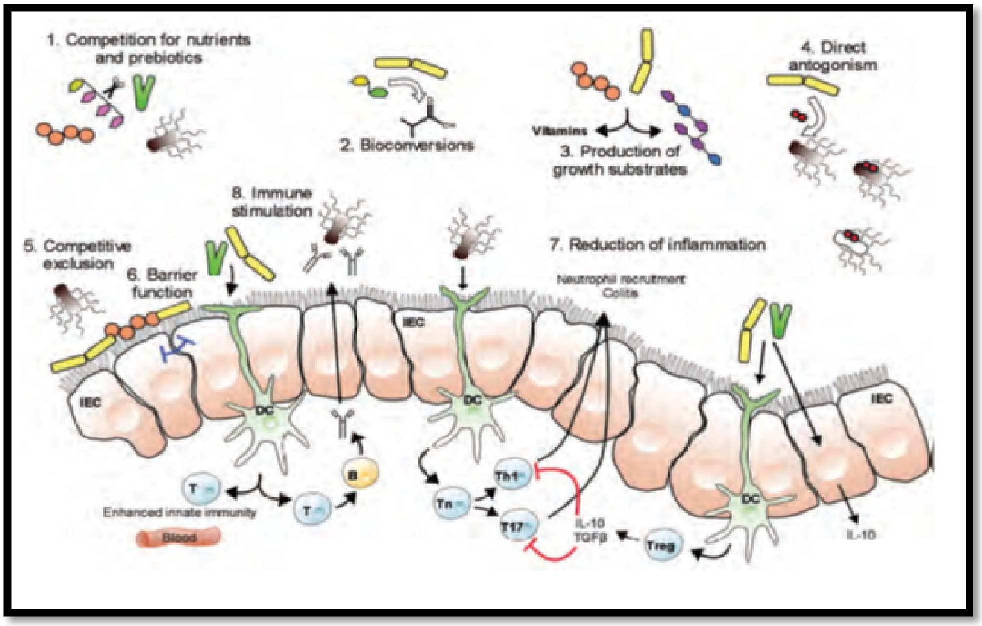

Figure 1
(O'Toole and Cooney, 2008)

These mechanisms include (1) competition for dietary ingredients as growth substrates, (2) bioconversion of, for example, sugars into fermentation products with inhibitory properties, (3) production of growth substrates, for example, EPS or vitamins, for other bacteria, (4) direct antagonism by bacteriocins, (5) competitive exclusion for binding sites, (6) improved barrier function, (7) reduction of inflammation, thus altering intestinal properties for colonisation and persistence within, and (8) stimulation of innate immune response (by unknown mechanisms). IEC, epithelial cells; DC, dendritic cells; T, T cells.

Health Benefits	Proposed Mechanisms Involved
Resistance to enteric pathogens	Antagonism activity Adjuvant effect increasing antibody production Systemic immune effect Colonization resistance Limiting access of enteric pathogens (pH, bacteriocins/defensins, antimicrobial peptides, lactic acid production, and toxic oxygen metabolites)
Aid in lactose digestion	Bacterial lactase acts on lactose in the small intestine
Small bowel bacterial overgrowth	Lactobacilli influence the activity of overgrowth flora, decreasing toxic metabolite production Normalization of a small bowel microbial community Antibacterial characteristics
Immune system modulation	Strengthening of nonspecific and antigen-specific defense against infection and tumors Adjuvant effect in antigen-specific immune responses Regulating/influencing Th1/Th2 cells, production of anti-inflammatory cytokines Decreased release of toxic N-metabolites
Anticolon cancer effect	Antimutagenic activity Detoxification of carcinogenic metabolites Alteration in pro-cancerous enzymatic activity of colonic microorganisms Stimulation of immune function Influence on bile salt concentration
Decreased detoxification/excretion of toxic microbial metabolites	Increased bifidobacterial cell counts and shift from a preferable protein- to carbohydrate-metabolizing microbial community, less toxic and for putrefactive metabolites, improvements of hepatic encephalopathy after the administration of bifidobacteria and lactulose

Health Benefits	Proposed Mechanisms Involved
Allergy	Prevention of antigen translocation into blood stream Prevent excessive immunologic responses to increased amount of antigen stimulation of the gut
Blood lipids, heart disease	Assimilation of cholesterol by bacterial cell Alteration in the activity of BSH enzyme Antioxidative effect
Antihypertensive effect	Bacterial peptidase action on milk protein results in antihypertensive tripeptides Cell wall components act as ACE inhibitors
Urogenital Infections	Adhesion to urinary and vaginal tract cells Competitive exclusion Inhibitor production (H_2O_2, biosurfactants)
Infection caused by Helicobacter pylori	Competitive colonization Inhibition of growth and adhesion to mucosal cells, decrease in gastric H. pylori concentration
Hepatic encephalopathy	Competitive exclusion or inhibition of urease-producing gut flora
Neutralization of dietary carcinogens	Production of butyric acid neutralizes the activity of dietary carcinogens
NEC (necrotic inflammation of the distal small intestine)	Decrease in TLRs and signaling molecules and increase in negative regulations Reduction in the IL-8 response
Rotaviral gastroenteritis	Increased IgA response to the virus
Inflammatory bowel diseases, type I diabetes	Enhancement of mucosal barrier function
Crohn's disease	Reduction in proinflammatory cytokines including TNFα, reduction in the number of CD4 cells as well as TNFα expression among intraepithelial lymphocytes
Caries gingivitis	Reduction in gingivitis by L. reuteri, affects on streptococcus mutants, colonization of the teeth surface by lactobacilli Less carries after the ingestion of living or oral vaccination with heat-killed lactobacilli
Enhanced nutrient value	Vitamin and cofactor production

Table 2: Health B Mechanisms Involved
(Source: Napgal Et Al., 2012)

4. Foods That Serve as Carriers for Probiotics

According to Napgal et al. (2012), Probiotics are normally added to foods as part of fermentation process. In order to exert health benefits, probiotic bacteria must remain viable in food carriers and survive the harsh conditions of the GI tracts. Although dairy based products are suggested to be the main carriers for delivery of probiotics, other such as soy and fruits can be exploited as a potential carrier of probiotic microorganisms because of the increasing demands for new flavour and taste among consumers. Table 3 below showed foods that serve as carriers for probiotics.

4.1. Details of the Products That Serve as Carriers for Probiotics

Carrier	Products	Probiotics	References
Dairy based	Sweet-acidophilus milk	L. gasseri	Usman and Hosono (1999)
	Ice cream	L. johnsonii	Alamprese et al. (2002)
	Whey drink	L. casei	Drgalić et al. (2005)
	Whey cheese	B. animalis, L. acidophilus, L. brevi, L. paracasei	Madudeira et al. (2005)
	Natural-set yogurt	L. acidophilus, L. casei, Bifidobacterium	Donkor et al. (2007)
	Low-fat cheddar cheese	L. casei	Sharp et al. (2008)
	Yogurt	L. acidophilus, L. casei, B. bifidum	Sendra et al. (2008)
Soy based	Soymilk	Lactobacillus, Bifidobacterium, Streptococcus thermophiles	Donkor et al. (2007)
	Soy cream cheese	L. acidophilus	Liong et al. (2009)
	Soymilk	L. acidophilus, L. casei, Bifidobacterium	Yeo and Liong (2010)
	Soymilk	L. acidophilus, L. gasseri	Ewe et al.(2009)
	Soymilk	L. plantarum	Bao et al.(2011)

Table 3: Foods That Serve as Carriers for Probiotics
Source: Napgal Et Al., 2012

5. Conclusion

Probiotics has been established by various researchers to be useful in prevention and treatment of many diseases. Drugs of various classes have been used as therapeutic agents for various diseases but the side effects of these drugs have always been of great concern. At times the negative effects have been as terrible as the diseases. If probiotics is really looked into and use as alternatives for prevention and treatment of diseases, it will not only bring cure to diseases with little or no side effects, its palatability as food will make it easier and attractive to patients. Probiotics will come cheaper and save nations the huge amount of money spent on drugs. Of great advantage will it be in prevention and treatment of the three major diseases (diabetes, obesity and cancer) that are of great challenges to the world at large and Nigeria in particular. These diseases are becoming rampant and cost a lot to treat or manage.

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