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Role of probiotics in health and disease

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Abstract : Research which concerns the usefulness of Probiotics show increasing interest based on the rise of their publications, products and the awareness of the public of their benefits. There is increasing interest concerning Probiotics from the public, researchers, governmental organizations (such as the WHO/FAO) and medicinal and food companies. Probiotics means ''let good microbes work for you in different fields get their benefits and take a rest''. Such work will include, food digestion, production of useful products to destroy the bad microbes, complement the functions of the missed digestive enzymes (due to missed or defective genes), and to maintain the digestive system's pH, and so on. Probiotics will augment the efficiency of our biological fermentors, the digestive system. This review discusses the potential beneficial effects of probiotics in preventing and treating certain diseases as well as current and future perspectives of probiotic research.
Key words: Probiotic, Heath benefits, Infections, Disease managemen.

1. Introduction

''Health Canada defines functional foods as products that resemble traditional foods but possess demonstrated physiological benefits''[1]. Many unique traditional functional foods have been developed by combining food with herbal medicines. In some countries traditional herbal products are widely used as medicine in dietary supplements, daily foods and functional foods, for replenishment and health promotion purposes. The concept is connected with immunopotentiation, the improvement of system circulation, disease prevention, and control of aging[2].

According to the definition, functional food is a part of human diet and is demonstrated to provide health benefits and to decrease the risk of chronic diseases beyond those provided by adequate nutrition. The functional foods include: (i) usual foods with naturally occurring bioactive substances (e.g., dietary fibre), (ii) foods supplemented with bioactive substances (e.g., probiotics, antioxidants), and (iii) derived food ingredients introduced to conventional foods (e.g., prebiotics). Functional food should have a novel prospective, rather than a food product. It should also be mentioned that functional foods are not medicines such as pills or capsules but are consumed as part of a normal daily diet[3].

Epidemiological studies and randomized clinical experiments conducted have confirmed or at least suggested many health benefits for functional foods. The health benefits such as decrease of cancer risk, improvement of heart health, enhancement of immune system[4], reducing of menopause symptoms, enhancement of gastrointestinal health, preservation of urinary tract health, anti-inflammatory influences, diminution of blood pressure, protection of vision, antibacterial and antiviral activities, decline of osteoporosis

and antiobese influences. Prebiotics are short-chain carbohydrates (SCCs) that are non-digestible by digestive enzymes in humans and that have been called resistant SCCs[5].

In most countries, only general health claims are currently allowed on foods containing probiotics. The FAO/WHO Working Group[6] recommended that specific health claims on foods should be allowed relating to the use of probiotics, whenever sufficient scientific evidence is available. Such specific health claims should be permitted on the label and in promotional material. For example, a specific claim stating that a probiotic 'reduces the incidence and severity of rotavirus diarrhea in infants' would be more informative to the consumer than a general claim that states 'improves gut health'. The recommendation is that the product manufacturer should be responsible for conducting an independent third party review by scientific experts in order to establish the truthfulness of the health claims. In line with the suggestions of the FAO/WHO Working Group[6], on December 20, 2006, the European Parliament and the Council published a new regulation (No. 1924/2006) regarding ''Nutrition and Health Claims Made on Foods''[7].

This regulation applies to all nutritional and health claims relating to all types of food intended for final consumers; thus including probiotic products brought to the market with a health claim. The regulation aims to consolidate the nutrition and health claims at European level in order to better protect consumers, including commercial communications (labeling, presentation, and promotional campaigns), as well as trademarks and other brand names that could be construed as nutrition or health claims.

2. History and definition of probiotics

The Food and Agriculture Organization of the United Nations/World Health Organization (FAO/WHO) defined probiotics as living microorganisms, which, once administered in appropriate amounts, confer a health profit on the host. Stimulation or improvement of the defense system may be a mode of action by that probiotic exerts a helpful impact to the host[8]. Probiotics definition was initially commissioned to Lilly and Stilwell[9] who expressed probiotics as substances secreted by one organism that stimulate another organism. The nomenclature was then employed in 1971 by Sperti[10] who delineated tissue extracts that stimulate microbes' growth. The word was later described by Parker[11] in 1974 that advanced the definition by adding the word organisms, thereby describing probiotics as ''Organisms and substances that exert beneficial effects on the host by balancing its intestinal microbes.'' The definition was re-improved by Fuller[12] in 1989 whose explanation was as ''a live microbial feed supplement which beneficially affects the host animal by improving its intestinal balance.'' The term, probiotic was also defined by Gismondo et al., 1999[13] as ''for life,'' originating from the Greek words ''pro'' and ''bios.''

Recently, scientific data proved that the application of probiotic to the host get beyond its effects on the intestinal region to other desired effects[14]. Gram et al., (1999) broadened the definition by removing the restriction to the improvement to the intestine: ''a live microbial supplement which beneficially affects the host animal by improving its microbial balance.'' Moreover[15], Salminen et al., (1999) addressed probiotics as any live and dead microbes or their cellular fractions exerted beneficial effects on the host[16]. Biswas et al., (2013) recorded an in vitro modulation of immune response in the head kidney cells, organ responsible for immunity, of the Japanese puffer fish (*Takifugu rubripes*) after supplementation of heat-killed probiotics isolated from the Mongolian dairy products[16].

3. Modes of action

There have been several hypotheses for probiotics mode of actions in the host, most of the following actions have been observed during in vitro experiments; however there are needs to emphasize that the efficiency of a selected probiotic in vitro may significantly change when administered to the host in its natural environment, probiotic organisms are influenced by more complex factors among which selective ingestion[17], the manipulation in the intestinal tract[18] and the more complex microbial interactions and/or nutritional environment are of premium importance. We can rely on the aforementioned factors in the success or failure of the probiotic in maintaining its in vivo physiology. In general, there is still an incomplete correlation bond between in vitro and in vivo experiments to explore the claimed mechanisms of probiotic actions. The following are reviews for the different action modes and applications of probiotics in aquatic hosts.

4. Competition for nutrient and energy sources

The hypothesis of competition on energy sources and adhesion sites helps in the selection phenomena can be proposed as one mode of action for probiotics. Theoretically, competition for nutrients can play an important role in the composition of the microbiota of the intestinal tract or the surrounding environment of cultured aquatic species[14]. Increasing some strains of bacteria such as Lactobacillus and Bacillus by way of a probiotic may thereby decrease the substrate available for other bacterial populations[19]. The impact was not solely caused by extra cellular product, however conjointly needed the live microbial cell, though further testing is needed, they hypothesized that the protecting impact most likely resulted from competition for energy sources and for adhesion sites.

5. The role of probiotics in growth enhancement

Among the various benefits of probiotics in aquaculture, the growth enhancement of the cultivated species is of premium importance. Typically this benefit is postulated to occur via the gut and is assumed to be as a result of bacterial species colonizing the gut of the host and bringing about a change in the bacterial composition of the gut that in some way benefits the health of the host[17]. There have been many speculations for this positive phenomena, probiotic products increase the appetite, improve digestibility[20]. Balcazar et al., (2006) proved that probiotic microorganisms are able to colonize gastrointestinal tract when administered over a long period of time[17]. Limiting factors control the colonization process from which body temperature, species genetic resistance, enzyme levels and water quality. Probiotic supplementation increase the absorbance efficiency of feeds[21], in this contest, several studies proved that the ability of the probiotic to compose proteases, amylases, and lipases, vitamins, fatty acids, and amino acids as a cofactor for the digestive process aid the improvement in the growth performance[17].

6. The role of Probiotics in disease treatment

The role of Probiotics in such types of cases will be in removing such deficiencies by different mechanisms such as (i) supplying our bodies with the products of the missed gene products, (ii) supplying our bodies with suitable alternative products, (iii) supplying our bodies with the final products of a complete pathway which will be the best choice and in the case that none of the defective pathway metabolic intermediates will be accumulated in our cells in the case of a single or multiple gene deficiency which could block a certain pathway[22], (iv) Probiotics could support a weak (rather than a completely defected pathway) pathway which might be due to a defect in a single allele rather than the defect in both alleles. Exactly like in the case of those who have retinoblastoma. In such a case the critical basis for the Knudson hypnosis's will be completely interfered with while a single gene will not be a subject to excessive stress that could lead to a mutation[22], (v) Probiotics will be the best support for us when we become old. It will reduce the load on our biological system and will enable us to do extra activity, particularly those related to improving our ability to utilize food. Here are some roles for Probiotics in maintaining our health, in disease treatment and management:

- Suppression of the putrefactive-type fermentation which was one of the Ilya Ilyich Metchinkoff postulations about the usefulness of Probiotics[23].
- Used to reduce the antibiotic destructive effect and to regenerate any type of loss in beneficial microflora. Some Bacillus species are recommended for use with antibiotics while they are resistant to them[24].
- Treating of the diarrheal disorder. Saccharomyces cerevisiae var boulardii was used widely for treating various diarrheal disorders[25].
- Improving intestinal tract health[26].
- Enhancing the immune system, synthesis and enhancing the bioavailability of nutrients[27].
- Reducing symptoms of lactose intolerance and decreasing the prevalence of allergy in susceptible individuals[25].
- Reducing the risk of certain cancers[28].
- Control of serum cholesterol levels[29].
- Improved digestion of lactose against foods containing lactose.
- Probiotics may also influence the protective functions of the intestinal mucosa including the synthesis and secretion of antibacterial peptides[24].
- Hypertension (Blood pressure control)[29].
- Condition of the genitourinary tract[23].

Aiba et al. (1998) showed Lactobacillus salivarius capable of producing high amounts of lactic acid, which can inhibit the growth of H. pylori in vitro[30]. There is some preliminary evidence that Probiotic bacteria may inhibit the gastric colonization and activity of H. pylori, which is associated with gastritis, peptic ulcers and gastric cancer. L. salivarius was found to inhibit H. pylori colonization in the in vitro studies as well as in mice[27]. The use of Probiotics in the field of H. pylori infection has been proposed for improving the eradication rate and tolerability and for the compliance of multiple antibiotic regimens used for the infection[31].

Genotoxic enzyme activity has been found to decrease upon the administration of prebiotics. An early study on feeding GOS to humans resulted in a decrease in nitroreductase (a metabolic activator ormutaganic/carcinogenic substances) and also decreased levels of indole and isovaleric acid (produced as products of proteolysis and deamination and markers of putrefaction)[32]. When a model system of the human gut was used to investigate the effect of galactooligosaccharides on genotoxic enzymes, it was found that bglucosidase, b-glucuronidase, and arylsulphatase were strongly inhibited[33].

7. Lipid regulation

Prebiotics may also have an effect on lipid regulation. Although the mechanism is currently unknown, studies have shown positive results and mechanistic hypotheses have been developed. A study on diabetic rats found that when xylooligosaccharides (XOS) replaced simple carbohydrates in the diet, the serum cholesterol and triglyceride increases observed in diabetes were reduced and liver triacylglycerols increased to a comparable level to that seen in healthy rats[34].

Epidemiological studies on prebiotics Although convincing lipid-lowering effects of the fructooligosaccharide inulin have been demonstrated in animals[35], attempts to reproduce similar effects in humans have produced conflicting findings. This may be because of the much lower doses which can be used due to the adverse gastrointestinal symptoms exhibited by most subjects consuming inulin in excess of 15 g/d. There are nine studies reported in the literature which have investigated the response of blood lipids (usually total and LDL-cholesterol and triacylglycerol) to inulin or oligofructose supplementation in human volunteers[35].

8. Applications of prebiotics in food products

The utilisation of prebiotics as food components has multiple advantages, since they improve sensory features and provide a more well-balanced nutritional composition[36]. When prebiotics are used in bakery products and breakfast cereals, this represents major progress in comparison with classical dietary fibre. Prebiotics provide more freshness in snacks and cereals and they prolong shelf life. They also keep breads and cakes moist and fresh for a long time. Their solubility allows fibre incorporation in liquid systems such as drinks, dairy products and table spreads. Prebiotics are also often utilised as dietary fibre in tablets and in functional foods, particularly in entire ranges of dairy products and breads, as prebiotic ingredients enhance the viability of healthy intestinal bacteria[37]. Because of their gelling properties, prebiotics improve low fat foods without any adverse effect on taste or texture. This is important in products such as table spreads, butter-like products, dairy spreads, cream cheeses, and processed cheeses. The addition of prebiotics allows for the replacement of a considerable quantity of fat and the maintenance of the emulsion, while offering a spreadable texture. Exceptional results have been found in water-in-oil spreads[38].

The addition of prebiotics to fat-reduced meat products leads to a creamier, juicier mouthfeel and constancy because water hold is maintained. Prebiotics have also been added as low energy ingredients and as fibre in chocolate products without added sugar. In the dairy market, dietary products have shown the strongest development, especially for diet yoghurts with fruit[39]. The addition of prebiotics in the recipe during fruit preparation develops mouthfeel, diminishes syneresis and presents a synergistic taste result in combination with aspartame and acesulfame K, without any significant increase in the caloric content[40].

9. Conclusion

Prebiotics have a significant effect on human health and have greater possibilities for incorporation into a wide range of common foodstuffs. Their role is played by fermentable carbohydrates, which stimulate, preferentially, the growth of probiotic bacteria (bifidobacteria and lactic acid bacteria), thus enhancing the gastrointestinal and immune systems. In addition, prebiotics have been shown to increase the absorption of

calcium and magnesium, influence blood glucose levels and improve plasma lipids. Long terms clinical trials are required to confirm the health benefits of prebiotics in human.

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