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Food Science and Nutrition Technology
ISSN: 2574-2701

Preventive Aspects of Prebiotics and Probiotics in Food Hypersensitivity

Review Article
Volume 1 Issue 1
Received Date: May 30, 2016
Published Date: June 16, 2016

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Abstract

Food allergic disorders are contributing a serious health complication in the developed as well as developing world. The paediatric age group is more prone to allergic diseases as compared to other age group and show more symptoms of these disorders. Besides the dictionary of pharmaceuticals for curing allergic symptoms, there is also a world of microorganism that emerges as a future therapeutic weapon against various allergic diseases. Several studies suggest the role of prebiotics and probiotics in curing allergic diseases. We have reviewed the published reports and discussed mainly the prospective uses in the field of food allergic diseases, with reference to the implication of the natural immune system as regulator of the development of abnormal responses to ingested food antigens and its possible impact on future market of health.

Keywords: Probiotics; Prebiotics; Food Allergy; Anaphylaxis; Innate Immunity

Introduction

Food hypersensitivity or food allergy is a prevalent health problem associated with the developed as well as developing countries. Approximately 6% of infants and 3.7% of adults with an age less than 3 years have been reported to be prone of food hypersensitivities [1]. Genetic and environmental predisposition plays key role in the prevalence of the food hypersensitivity reactions in the susceptible individuals [2]. In food allergy, the immune system is provoked by certain foods and induces the production of immunoglobulin E (IgE). The allergen is a certain protein of a food, having an IgE binding region or epitope which possess immune eliciting characteristics. The IgE binds to the specific epsilon receptor, FcεR1 present within the membrane of mast cells and basophils [3]. Secondary exposure of same or similar allergens get cross linked with IgE which lead to the degranulation of mast cells or basophils after a cascade of reactions. These allergic reactions resulted in release of allergic mediators like histamine, leukotrienes, prostaglandins as well as other chemical mediators, into the bloodstream [4]. These mediators may induce a range of signs and symptoms related to allergy including dripping nose, itchy eyes, dry throat, rashes and hives, nausea, diarrhea, labored breathing, and sometime anaphylactic shock which may lead to death [5].

The increase in the number of incidences of the food allergic disorders in the recent years has raised an alarming concern around the globe and therefore, an urgent need of some pivotal therapeutics to combat this issue effectively is highly required. Several therapeutics for food allergy are on the trial including the allergen immunotherapy, Chinese herbal therapy, anti-IgE therapy, use of probiotics and utilization of engineered lactic acid bacteria [6,7]. Considering the side effects as well as the higher price of allopathic medicines, use of prebiotics and probiotics have been coming in the limelight now a day's [8]. The human gut ecosystem is the habitat of the several beneficial commensal microflora or probiotics e.g.,

Lactobacillus sps which may contribute to human health in a positive way. Prebiotic are dietary supplements mainly in the form of nondigestible fiber that assists the growth of the gut commensals. Today's market of health has a broad range of prebiotic supplement such as fructooligosaccharides (FOS), xylooligosaccharides (XOS), polydextrose and galactooligosaccharides (GOS). Probiotics like Bifidobacterium and lactobacillus are microflora population that resides in the gut and digestive tract and provides positive health effects and boost the immunity in humans [9,10]. These microfloras provide resistance against several diseases including allergy and prohibit the growth of pathogenic bacteria. Probiotics are groups of the non pathogenic population of commercials which growth can be enhanced by the use of prebiotics [11]. Prebiotics and probiotics are landmark approach in the treatment of food allergy with a minimized possibility of adverse effects. This review focuses on the beneficial role of probiotics and prebiotics in the possible treatment of food allergic reactions.

Prebiotics are dietary fiber or nondigestible substances, beneficial to the biological system and stimulate the growth of beneficial microorganisms. It supports the survival and health of the probiotics in the gut of the animals including human. These are nondigestible parts of food that act as a source of nutrition for the probiotics. Further, prebiotics may alter the pH of the colon which ultimately enhances the absorption of certain minerals, including calcium, iron and magnesium [12]. Modern dietary changes have been found to be linked with the prevalence of the allergic diseases which needs to be reconsidered in the susceptible patients. Supplementation of the dietary nutrients to assess the preventive merits of specific immunomodulatory effects such as polyunsaturated fatty acids, antioxidants, folate, and vitamin D have been well studied [13]. Significance of prebiotics with respect to human health and their application are given in Table 1.

Prebiotics

S.No	Name of Prebiotic	Human Applications
1	Chicory Root	Chicory is a prebiotic food and help in the prevention of cardiovascular disorders, constipation, constipation, diarrhea and cancer [42].
2	Oats	Oats is a source of soluble fiber and its high intake lowers blood cholesterol levels, protect from coronary heart diseases, skin irritation and colon cancer [43].
3	Barley	Barley is a source of soluble fiber contains several vitamins like vitamins B1, B2, B6, B12, pantothenic acid, and folic acid and also possesses antioxidant activity [44].
4	Legumes	Legumes provide protein, fiber, folate and iron, in addition to being a prebiotic. These are excellent source of antioxidants and rich in folate, calcium, zinc, iron and selenium [45].
5	Garlic	Garlic is an important source of prebiotic for the friendly gut bacteria, and also rich in antioxidants [46].

Table 1: Indicating the major prebiotics and their application on human health.

Prebiotics in food allergy

The prebiotics have been reported to be used as therapeutics in some diseases including food allergy. These nondigestible carbohydrate mixtures have been used to diminish allergic disease in the infants at risk and other age group as well [14,15]. Non-digestible oligosaccharides supplemented to the diet have been found to exert immunomodulatary responses in the gut. Recently, in one of the studies carried out by Eiwegger et al. (2010) exploring the effect of prebiotic supplements of infant formula short chain galactosaccharides (scGOS), and long chain fructo-oligosaccharides (lcFOS) showed preventive effects of these prebiotics on atopic diseases. Human milk, have been reported to reduce the development of allergic manifestations, by the immunomodulation and positive change in the intestinal microbiota [16]. AHMOS significantly suppressed Th-2 type cytokine-production by Ara h1-specific CD4+ T cells (CFSE (low) CD3 (+) CD4 (+) cells) from peanut allergic patients. The mother's milk has some vital acidic oligosaccharides which has the capacity to reduce allergen-specific immune responses in the neonates via suppressed Th-2-type responses [17].

Enzyme-treated rice fiber (ERF) is a recently developed prebiotic product made from rice bran by heatresistant amylase, protease and hemicellulase treatment. It was found that ERF significantly attenuated the T cell activation (CD4+CD69+) of spleen and mesenteric lymph node (MLN), and this characteristic was inherited by the transferred mice. Further, ERF significantly suppressed

the growth of *Clostiridium*, and increased short-chain fatty acids (acetate, propionate and butyrate) content in colitis. The relatively hydrophilic fraction of ERF (ethanol-increase the amount of lactic acid producing bacteria, increases the amount of short chain fatty acids, activates carbohydrate receptor immune cells, increase absorption of vitamins and minerals. Prebiotics cause their effects methanol soluble fraction) is therefore considered to have a potent ability to attenuate the induction of dendritic cells or DCs [18]. Prebiotics have been reported to through the metabolism of the bacteria they promote. A brief outline of prebiotics functions has been given in Figure 1.

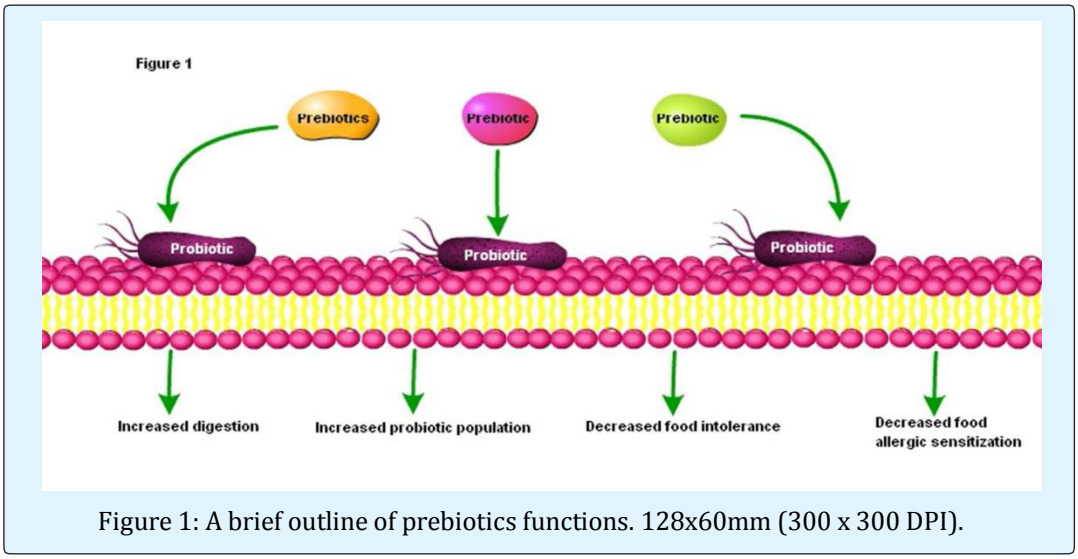

Figure 1: A brief outline of prebiotics functions. 128x60mm (300 x 300 DPI).

Probiotics

Probiotics are commensal bacteria, resident of the digestive tract of the animals, and provides support to a good health [19]. According to World Health Organization (WHO), probiotics; live micro-organisms when administered in appropriately confer a profound health benefit to the host [20]. Consumption of prebiotic supplements with probiotics can help to attain equilibrium in the population of beneficial bacteria in gut [21]. Significance of prebiotics with respect to human health and their application are given in Table 2.

S.No	Probiotic	Human Applications
1	*Bifidobacterium bifidum (lactis)*	B. bifidum produces lactic and acetic acids, which lower the intestinal pH and inhibit the undesirable bacteria from growing and also enhance the absorption of minerals such as iron, calcium, magnesium and zinc [47].
2	*Bifidobacterium infantis*	Bifidobacterium infantis stimulates formation of cytokines. Also help against pathogens as Clostridia, Salmonella, and Shigella [48].
3	*Bifidobacterium longum*	Bifidobacterium longum produces several organic compounds such as lactic acid, acetic acid and hydrogen per oxide that inhibits the encounter of pathogenic organisms [49].
4	*Lactobacillus acidophilus*	L. acidophilus produces natural antibiotics like lactocidin, acidophilin, etc., which provides immunity [50].
5	*Lactobacillus brevis*	L. brevis is a lactic acid producing organism important in the synthesis of vitamins D and provides anti-inflammatory advantage to human digestive system [51].
6	*Lactobacillus bulgaricus*	Lactobacillus bulgaricus is lactic acid by the bacterium provides a favorable environment for the growth of other lactobacilli and bifidobacteria residing in the intestine [52].
7	*Lactobacillus casei*	It also reduces lactose intolerance; modulate immune system. It has also major role in preventing Diarrhea in ill children [53].

8	*Lactobacillus plantarum*	Lactobacillus plantarum found in GI tract of humans. It is involved in curing soy related allergies. It reduces the abdominal bloating in patients with irritable bowel syndrome [54].
9	*Lactobacillus rhamnosus (casei)*	Lactobacillus rhamnosus reduces diarrhea occurred due to use of antibiotics [55].
10	*Lactobacillus salivarius*	Lactobacillus salivarius reducing the plaque formation in mouth [56].

Table 2: Indicating the major probiotics and their application on human health.

Probiotics in food allergy

Certain cell populations in the intestinal mucosa monitor the gut flora that recognize pathogens and transfer signals to other immune cells. These signals trigger inflammation or help to avoid inadequate stimulation, by two major recognition biological and host pattern recognition receptor systems, the Toll-like receptors (TLRs) and the nucleotide oligomerization domain (NOD). Intestinal epithelial cells recognize microbes and their products via TLRs and subsequently activate the host immune system and protective mechanisms that allow differentiation between commensal or pathogenic microorganisms established. The DCs have been found to project long processes through the intestinal epithelial cells to sample a luminal microbial product, which leads to direct DCs cell–microbe contact via TLR receptors [22].

Probiotics containing, for example, Bifidobacterium bifidum and Streptococcus thermophilus when administered in children with rotaviral diarrhea, results in faster seroconversion within IgA and IgM antibodies accompanied by growth of cells producing IgM antibodies [23]. Enzymatic hydrolysis with the participation of probiotics increases the bio accessibility of lipids and proteins and reduces allergen city of foodstuffs [24]. There is increase in the level of folic acid, niacin and riboflavin up to 20 fold by the application of probiotics [25]. Probiotics also synthesize the B group and K vitamins as well as some cytoprotective short chain fatty acids [26]. Figure 2 demonstrating the effect of probiotics bacteria on the gut immune system.

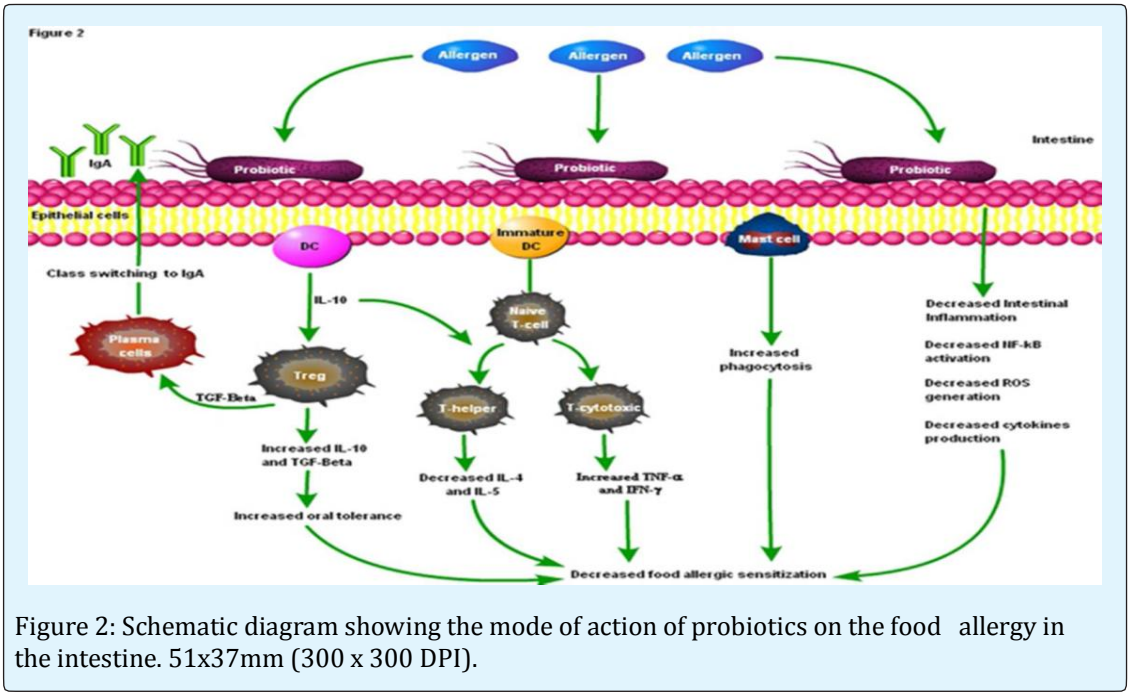

Figure 2: Schematic diagram showing the mode of action of probiotics on the food allergy in the intestine. 51x37mm (300 x 300 DPI).

Oral tolerance is an immunologic hypo response to an orally administered antigen and is important in preventing unnecessary gastrointestinal tract inflammation, which can result in a number of autoimmune and hypersensitivity diseases. Probiotics T regs and DCs are all essential for generating tolerance. Further, antibiotic treatment resulted in a significant decrease in the tolerogenic CD11c (+)/CD11b (+)/CD8α (-

) mesenteric lymph node DCs independent of tolerizing treatment. Antibiotic treatment, potentially through its effects on tolerogenic DCs and intestinal microflora, may contribute to atopic disorders via a breakdown in tolerance [27]. Several studies on human in the regards of the use of probiotics as a treatment for allergy indicated a reduced severity in the atopic dermatitis index levels in patients [14]. The effect of oral probiotics bacteria administered at different times on ovalbumin-sensitized rats were investigated and it was found that both probiotics prevention and probiotics treatment could attenuate the food allergic response via reduction of ovalbumin specific IgE, level, intestinal barrier function and immune responses [28].

The allergy-reducing effects of probiotics namely VSL#3 via low doses of an allergen supplementation in β-lactoglobulin-sensitized mice was carried out by Thang CL et al. [29]. In this study, it was explored that that supplementation of VSL#3 suppressed the allergic reaction mainly through increased intestinal secretary IgA (sIgA) in mice, and oral tolerance offers allergen –specific protective effect to BGA-induced allergy, probably through CD4+CD25+ regulatory T cell (Treg) mediated active suppression [29]. Specific probiotics may modulate early microbial colonization, which represents the first intervention target in allergic disease, together with their ability to reverse the increased intestinal permeability characteristic of children with atopic eczema and food allergy and it was also found that probiotics enhance gut-specific IgA responses, which are frequently defective in children with food allergy and systemically [30]. Fermented milk supplemented with 2 probiotics strains, Bifidobacterium lactis Bi-07 and Lactobacillus acidophilus NCFM, and a prebiotics, isomaltooligosaccharide, was orally administered to 100 healthy adults at 480 g/d for 2 wk in a randomized controlled trial and a significantly increased delayed-type hypersensitivity, plaque-forming cells, and half-hemolysis values after the intervention with the fermented milk and the symbiotic fermented milk containing probiotics and a prebiotics may contribute to improve intestinal health and may have a positive effect on the humoral and cell-mediated immunity of host animals [7]. Probiotics have many effects on intestinal function and immune responses, including repair of intestinal barrier function, restoration of tight junctions, and enhanced mucin production, effects on DCs function and skewing of T cells toward Th1 polarization, competitive exclusion of pathogens, suppression of intestinal inflammation through down regulation of TLR expression and secretion of metabolites that may inhibit TNF-α secretion by blood mononuclear cells and through inhibition of NF-κB signalling in enterocytes [31]. Schematic diagram showing the mode of action of probiotics on the food allergy in the intestine is given in Figure 2.

Synbiotics

Probiotic alone are not functional food developed for the improvement of the human health by immunodulatory effect and gut modulatory effect. But, symbiotic encourage the growth of probiotic organism by providing the specific substrate to the probiotics organism for its fermentation [32,33]. Recently, Su et al. has been reported the combination of one prebiotic along with the one probiotic is administered and fecal samples were analyzed and observed that FOS diet encourages the growth of L. Acidophilus [34]. Another study on human also administered the GOS with probiotic LGG and was found to have significantly increased in Lactobacillus rhamnosus and bifidobacteria in feces of treated childrens [35]. The symbiotic approach of combination of bifidobacterium longum along with inulin oligofructose in a patient of ulcerative colitis shows reduction in inflammation [36]. The food allergy preventive effect on children in one research shows reduction in childhood eczema on administration of four probiotic along with GOS [37].

Future market of prebiotics and probiotics

Is probiotic and prebiotics approach for the remediation of the several allergic diseases and food hypersensitivity reaction is safe? To derive the conclusion and answer of this problem current research is not perfect, as it needs several human trials. A preventive measure of the allergic response is the synergistic effect of prebiotics and probiotics. There is golden future market of both, as they are competing with the pharmaceutical market. Now a day's prebiotics and probiotics market is emerging as a hope to provide a healthy and safe tomorrow for the people of both developing as well as the developed world. The days are not so far when these microorganisms win the battle of success against the drugs and pharmaceutical products that are showing several side effects. Food companies will continue to research new functional food products, resulting in the association of more food ingredients with health claims. Given the heightened concern over antibiotic resistance, natural alternatives such as probiotics for inhibition of pathogens are becoming more attractive. In fact, the World Health Organization (WHO) recommends global programs to reduce the use of antibiotics in animals, plants and fishes, for promoting livestock growth and inhuman medicine and recommends increased efforts to prevent disease through increased immunization with existing vaccines and through the development of more effective and safer vaccines. Prebiotics do not suffer from any such constraint and can

be used in a wide range of food products. Probiotics do not have a long shelf life in their active form. In most cases, refrigeration is required to maintain the shelf life [38]. While probiotics are predominantly used in fermented dairy products, the use of prebiotics has expanded into other food categories. Prebiotics have successfully been incorporated in a wide variety of human food products such as baked goods, sweeteners, yoghurts, nutrition bars, and meal replacement shakes [39]. Additional understanding of the interplay between immunologic, genetic, and environmental factors underlying food allergy development need to be clarified before probiotic therapeutic interventions can routinely be recommended for prevention or mitigation of food allergies. Such interventions may be well-suited in male infants and in infants born to older mothers [40]. The safety of probiotics for subjects with food allergy in 5 children allergic to cow's milk, 5 children allergic to hen's white egg, and 5 control subjects non-allergic to commercially available in Spain were examined to assess their content of cow's milk or hen's egg. Probiotics compounds may contain hidden allergens of food and may not be safe for subjects with allergy to cow's milk or hen's egg [41]. Strikingly, certain strains may worsen the allergic reaction as shown in the case of WCFS1 [33]. Further, product launches are expected in several areas, including sport-related products, fortified foods and drinks, and dairy products such as yogurts, cheese, ice cream, and milks containing prebiotics and probiotics. Despite these observations, however, much research is still needed to determine the true efficacy and safer use of prebiotics and probiotics for the allergy free world.

Conclusion

The present and proposed implication of prebiotics and probiotics covers a broad range of allergic diseases and disorders including food allergy. Medical uses of both of these are also increasing now a days for curing allergic diseases in humans. By using prebiotics and probiotics, one can improve the gut composition and ecosystem along with host health. A wide listing of prebiotics and probiotics is mentioned in this article that has a positive approach to the human health. The pharmaceuticals are now being replaced with this approach eliciting its non adverse response on human health. The future market of prebioitics and probiotics are also replacing the pharmaceuticals and drugs available for the treatment of the allergic diseases. But there is also a need to explore other microfloras and prebioitic sources for curing other diseases. Both of these are emerging as a future hope around the globe for providing a disease and allergy free world. Overall, probiotics and prebiotics appear to be future weapons for allergic diseases.

Acknowledgement

I am thankful to Indian Institute of Toxicology Research (CSIR) India.

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