FOOD ALLERGY: ITS CONTROL BY PROBIOTIC - A REVIEW

Shovna, Suja Senan and J.B. Prajapati
Department of Dairy Microbiology, S. M. C. College of Dairy Science, Anand Agricultural University, Anand- 388 110, India

Received: 09-12-2012 Accepted: 09-10-2013

ABSTRACT

The cultural diversity of the globe is reflected in the multitude of dietary habits and culinary choices among the people. In this diversity there exists a group of people who have developed an allergic reaction towards some foods. Food allergy is now recognized as a worldwide problem and appears to be on increase because of lifestyle changes in modern times such as changes in the alimentary habits, living conditions, excessive use of antibiotics contributing to immune-deviation. Pharmaceutical medicine has been unable to stop the increasing global morbidity and mortality both in acute and chronic allergic diseases. In view of this, there is a growing awareness of the preventative and therapeutic potential of alternative agents in the medical field. Probiotics, amongst other agents fall into this category and can have direct and positive effect on the prevention of allergic disorder. Many studies have been performed which indicate that probiotics can temporarily modify the composition of gut microbiota, and potentially these can reduce susceptibility to allergy, leading to health benefits for the host.

Key words: Allergy, Hypersensitivity, Immunoglobulins, Mechanism, Probiotics.

Food allergy, defined as an adverse immune response to food proteins, affects as many as 6% of young children and 3-4% of adults in the world (Sicherer 2006). Food allergies are much more common in India as compared to the western countries with a figure quoting 16-20%. In young children the most common allergy causing foods are cow milk(2.5%), egg(1.3%), peanut(0.8%), wheat(0.4%), soy(0.4%), nuts(0.2%), fish(0.1%) and shellfish(0.1%)(Wood, 2003).

Allergy is an immediate hypersensitivity disorder (type I) of the immune system. The word allergy derives from the Greek words allos"meaning other and ergon"meaning "reaction" or "reactivity". Allergic reactions occur to normally harmless environmental substances known as allergens; these reactions are acquired, predictable, and rapid. Risk factors for allergy can be host and environmental factors. Host factors include heredity, gender, race, and age, with heredity being by far the most significant. However, there have been recent increases in the incidence of allergic disorders that cannot be explained by genetic factors alone. Four major environmental candidates are alterations in exposure to infectious diseases during early childhood, environmental pollution, allergen levels, and dietary changes.

The protein in the food is the most common allergic component. These kinds of allergies occur when the body’s immune system mistakenly identifies a protein as harmful. Some proteins or fragments of proteins are resistant to digestion and those that are not broken down in the digestive process are tagged by the Immunoglobulin E (IgE). These tags fool the immune system into thinking that the protein is harmful and triggers an allergic reaction. These reactions can range from mild to severe. Allergic responses include dermatitis, gastrointestinal and respiratory distress, including such life-threatening anaphylactic responses as biphasic anaphylaxis and vasodilation; these require immediate emergency intervention. Individuals with protein allergies commonly avoid contact with the problematic protein (Sampson, 2001).

General signs and symptoms of allergic reactions are: Hives, Itching of mouth, lips, tongue, throat, eyes, skin, or else areas, swelling (angioedema) of lips, tongue, eyelids, or the whole face, difficulty swallowing, runny or congested nose,
hoarse voice, wheezing and/or shortness of breath, nausea, vomiting, abdominal pain and/or stomach cramps, lightheadedness and fainting.

**Diagnostic tools for allergy**

**Skin prick test:** In this test, a tiny amount of the suspected allergen is put onto the skin or into a testing device, and the device is placed on the skin to prick. A hive will form at any spot where the person is allergic. This test generally yields a positive or negative result.

**Blood test:** It is useful diagnostic tool for evaluating IgE-mediated food allergies. For example, the RAST (Radio Allergo Sorbent Test) detects the presence of IgE antibodies to a particular allergen. A CAP-RAST test is a specific type of RAST test with greater specificity as it can show the amount of IgE present to each allergen (Wuthrich, 2005).

**Food challenges** are the gold standard for diagnosis of food allergies. The problem with food challenges is that they must be performed in the hospital under careful watch, due to the possibility of anaphylaxis (Sicherer, 2006).

**Mechanism of allergic reaction:** Normally immune system functions as the body’s defence against invading germs such as bacteria and viruses. When an allergic person comes into contact with an allergen, the immune system treats the allergen as an invader and gets ready to attack. The immune system does this by generating large amounts of type of antibody called “immunoglobulin E or IgE”. Each IgE antibody is specific for one particular substance. The IgE molecules are special because IgE is only one type of antibody that attaches tightly to the body’s mast cells, which are tissue cells and to basophils, which are blood cells. When the allergen next encounters its specific IgE, it attaches to the antibody like a key fitting into a lock. This action signals the cells to which the IgE is attached to release powerful chemicals such as histamines, which causes inflammation. These chemicals act on tissues in various parts of the body and cause the symptom of the allergy (Fiocchi et al., 2010).

Antigens give rise to immediate hypersensitivity. Hypersensitivity reactions are harmful antigen-specific immune responses, occur when an individual who has been primed by an innocuous antigen subsequently encounters the same antigen and produce tissue injury and dysfunction. There are 4 types of hypersensitivity reactions: Type I Hypersensitivity- IgE mediated, Type II Hypersensitivity- Antibody mediated, Type III Hypersensitivity- Immune complex, Type IV Hypersensitivity- Cell mediated

**Probiotics acting against allergic diseases:** There are certain strains of lactobacilli and bifidobacteria that can influence immune function through a number of different pathways including effects on erythrocytes, antigen presenting cells, regulatory T cells and effector T and B cells. Most studies to explore the role of probiotics in treatment of allergic diseases have focused on early manifestation of allergy.

**Evidence of Clinical Benefits of Probiotics in treatment of Food Allergy**

**Egg:** Hypersensitivity reactions can be caused due to dietary substances from the yolk or whites of eggs, causing an overreaction of the immune system which may lead to severe physical symptoms for millions of people around the world (Anonymous, 2005). Egg allergy is mainly caused by three proteins in the egg called ovomucoid, ovalbumin and conalbumin. Egg allergy is a rare occurrence in adults, but common in young children and it is usually outgrown by age 6. However a case was presented by Passeron et al (2007) wherein a female patient developed egg allergy in her 50s. Hives and atopic dermatitis are the most common allergic reactions to egg. It may also cause swelling of the lips, eyelids, tongue or throat. Adults with egg allergies may experience a variety of respiratory symptoms, including hay fever and asthma upon breathing powdered egg ingredients. Nasal symptoms may include itchy, watery eyes, runny or stuffy nose, and headache or sinus pressure. There may also be wheezing, coughing, difficulty breathing and other asthma symptoms.

Gruber et al (2007) investigated the therapeutic effect of Lactobacillus rhamnosus GG (LGG) as a food supplement in infants who had egg allergic parents and their parent suffered from atopic dermatitis. Allergic parents are more likely to have allergic children (Swert, 1999). It was observed that supplementation of food with lactobacilli may prevent or improve atopic dermatitis as infants who received lactobacilli pre- and postnatally were less likely to develop atopic dermatitis than placebo-fed infants (Rosenfeldt et al, 2003).
Babu et al (2010) hypothesized that newborn pigs pretreated orally with L. lactis are protected against allergy to ovomucoid (Ovm) and treatment with L. lactis significantly reduced subsequent frequency of allergy supporting “Hygiene Hypothesis” and use of L. lactis as an immunoregulatory prophylactic for allergy.

**Peanut:** An allergic response to peanuts usually occurs within minutes after exposure, and symptoms include: Skin reactions such as hives, redness or swelling, itching or tingling in or around the mouth and throat, digestive problems such as diarrhea, stomach cramps, nausea or vomiting, tightening of the chest, shortness of breath or wheezing and runny or stuffy nose. Peanut allergy is one of the most common causes of anaphylaxis.

A study conducted by Kalliomaki et al (2008) gives prospective study dividing newborn infants into two groups receiving either the probiotic Lactobacillus rhamnosus strain GG (ATCC 53103) or placebo. At 4 years of age, there was a significant decrease in the prevalence of atopic dermatitis (AD) in the Lactobacillus treatment group. However, the number of children with allergic rhinitis and asthma did not differ between the two groups. Oral administration of probiotics to children with food allergy, some of whom were allergic to peanut, is associated with a decrease in IgE production.

**Wheat:** Wheat allergy, once considered a disease of the western world, has been termed an ‘impending epidemic in India’ in an article published by Andrews et al (2011). The disease is not just affecting paediatric patients but adults too. There are four different classes of proteins in wheat that can cause allergies: albumin, globulin, gliadin and gluten. Twenty-seven potential wheat allergens have been successfully identified by Sotkovsky et al (2011).

Common symptoms of a wheat allergy include sacroiliitis, eczema (atopic dermatitis), hives (urticaria), asthma, Hay fever (allergic rhinitis), angioedema (tissue swelling due to fluid leakage from blood vessels), abdominal cramps, nausea, and vomiting. The most severe response is exercise/aspirin induced anaphylaxis attributed to one omega gliadin that is a relative of the protein that causes celiac disease. (Akagawa et al, 2007).

Lindfors et al (2008) investigated whether probiotics Lactobacillus fermentum or Bifidobacterium lactis can inhibit the toxic effects of gliadin in intestinal cell culture conditions. They observed that amongst the probiotics tested, live B. lactis could counteract directly the harmful effects exerted by coeliac-toxic gliadin and clearly warrant further studies of its potential as a novel dietary supplement in the treatment of coeliac disease. The efficacy of different numbers of both L. fermentum and B. lactis in inhibiting the gliadin-induced increase in Caco-2 cell permeability was assessed by TER measurement. B. lactis probiotic bacteria are able to protect epithelial cells from cellular damage induced by gliadin administration. Addition of B. lactis to the cell culture medium together with gliadin was able to counteract the gliadin-induced inhibition of TER recovery. Angelis (2006) aimed at showing the capacity of probiotic VSL #3 preparation (109cfu/ml) to extensively hydrolyze wheat flour gliadins as a tool for decreasing the level of toxic/immunogenic epitopes causing celiac diseases. Almost complete degradation of gliadins was seen during long-time fermentation of wheat flour by VSL #3.

**Soy:** It is not completely understood that which components of soy cause allergic reactions. There are at least 16 allergenic proteins in soy (Lalles et al, 1996). Amongst them soybean lectin, an antinutrient, has been identified as a major allergen. Whenever there is a damaged intestinal lining or “leaky gut”, soy lectin can easily pass into the bloodstream causing allergic reactions (Barnett et al, 1987). Symptoms for such allergic response are flushed face, hives, swelling of eyes, face, lips, throat and tongue, diarrhoea and rhinoconjunctivitis. Albert et al (2012) demonstrated that the probiotic Lactobacillus rhamnosus HN001 halves the prevalence of rhinoconjunctivitis at 2 years of age, continues to have a protective effect until the age of 4 years in infants whose mother were allergic to soy products. Maternal supplementation with HN001 from 35 weeks’ gestation until 6 months after birth, followed by infant supplementation until the age of 2 years, halves the cumulative prevalence of rhinoconjunctivitis in high-risk infants. Song et al (2007) evaluated the reduction of immunoreactivity by natural and induced fermentation of soybean
meal with L. plantarum, B. lactis and S. cerevisae. Naturally fermented and induced fermentation in soybean meals by use of probiotic bacteria and yeast showed highest reduction in IgE immunoreactivity, when compared with non-fermented soybean meals. Thus decreased immunoreactivity can be optimized to develop nutritious hypoallergenic soy products.

**Blueberry:** Blueberries contain “salicylate” which is a naturally occurring chemical compound in plants. Some individual experience an allergic reaction to blueberries, due to salicylate sensitivity. One common reaction to this allergy is swelling of lips, face, tongue and throat called angioedema (Moneret et al, 2005). Ciprandi et al (1986) reported that patients receiving adjunctive treatments with Bacillus subtilis spores resulted in significant reduction of frequency and severity of symptoms with angioedema manifestations from blueberry allergy. However, safety of using such spores in immune-compromised patients has been brought into a question (Oggioni et al, 1998).

**Seafood:** Seafood-borne allergic disease outbreaks affect consumers by a swollen throat (airway constriction), rapid pulse, shock, and dizziness, causing asthma. There is high allergic cross-reactivity among different types of fish. This is because of a protein (parvalbumin) that is present in many fish. For this reason, most of the people with an allergy to one fish are advised to avoid all fishes (Groce, 2008). Karimi et al (2009) reported that oral treatment with human intestinal origin live Lactobacilli reuteri (ATCC 23272) can attenuate the major characteristics of the asthmatic response caused by seafood allergens. Following 9 days of oral L. reuteri treatments, the percentage and total numbers of regulatory T cells (Foxp3+, CD4+ and CD25+) increased significantly which can attenuate the allergic airway response.

**Mushroom:** Members of the fungus family, mushrooms and mold trigger similar symptoms, including skin rashes and irritations including itchy eyes, mouth and throat, a runny nose, sneezing, swollen eyelids, headaches, breathing trouble and develop a rash or hives on skin. Basidiomycetes found in mushrooms are commonly responsible for mushroom allergy (Breitenbach, 2002). Morisset et al (2011) evaluated impact of a non hydrolyzed fermented infant formula containing heat-killed Bifidobacterium breve C50 and Streptococcus thermophilus 065 (HKBBST) with infants having mushroom allergy in family history. These infants in first 2 years of life suffered at high risk of atopy. Infants used HKBBST, a standard infant formula since birth until 1 year of age, and were followed at 4, 12 and 24 months after birth. HKBBST decreased the incidence of atopy in children with respiratory events, during the first months of life and after the formula was stopped.

**Food additives and preservatives:** Food additives such as Tartrazine, Sunset Yellow, Camosine, Sodium benzoate and Ponceau 4R generally used for preparation of sweets, ice cream, biscuits can also cause allergies (Keiko et al., 2010). Since it is probable that many allergic reactions to food additives and preservatives are not diagnosed, the exact rates of reactions are still unknown. However, various studies estimate that the rate is probably less than 1% of adults, and up to 2% of children (Daniel, 2011). Jones et al (2011) conducted double blind placebo controlled experiment on 114 subjects suffering from high cholesterol level due to coconut oil allergy. They aimed to evaluate the cholesterol-lowering efficacy of a yoghurt formulation containing in microencapsulated bile salt hydrolase (BSH) - active Lactobacillus reuteri NCIMB 30242, taken per day over 6 weeks. Over the intervention period, subjects attained significant reductions in LDL-cholesterol, total cholesterol and non-HDL-cholesterol over placebo.

**Milk:** A milk allergy is a state of intolerance for milk proteins which varies in severity. When the immune system is involved, usually due to reactions mediated by IgE, it is called cow’s milk protein allergy (CMPA). Well-known signs of milk allergy are skin rashes, sinus problems, wheezing, asthma attacks, diarrhea, and gastrointestinal discomfort. In acute condition eczema, autism and eosinophilic esophagatis are caused (Anon, 2010).

**Autism spectrum disorder:** The Autism spectrum disorders are more common in the pediatric population. Autism is a disorder of neural development characterized by impairment social interaction, communication, and by restricted and repetitive behavior. Walfson et al (2008) stated that probiotic species S. thermophilus may be capable of provoking an autoimmune response. Pediatric
Autoimmune Neuropsychiatric Disorders (PANDAS) and Autism Spectrum Disorders (ASD) are triggered or exacerbated by group A beta-hemolytic streptococcus (GABHS) infections. Anti-GABHS antibodies have been found in a person with ASD giving rise to concerns that other streptococcal organism, including S.thermophilus has antiallergic properties against cow’s milk protein allergy.

**Eczema** (from Greek word to boil over): It is a form of dermatitis, or inflammation of the epidermis (the outer layer of the skin). Marschan et al (2008) performed a clinical study in which mothers allergic to milk were allowed to receive capsules a day containing a mixture of four probiotic bacterial species Lactobacillus rhamnosus GG (ATCC 53103) 5 × 10⁹ colony-forming units (CFU), L. rhamnosus LC705 5 × 10⁹ CFU, Bifidobacterium breve Bb99 × 10⁹ CFU, and Propionibacterium freudenreichii ssp. Shermanii JS 2 × 10⁹ CFU. Their infants received the same capsules as the mothers once a day: those given probiotics were mixed with sugar syrup containing 0.8 g of prebiotic sugars (galacto-oligosaccharides). Mothers received these products for 2–4 weeks before delivery, and their infants for the first 6 months. In this clinical study, which included 925 children, the cumulative prevalence of eczema and atopic eczema by age 2 years was reduced in the children who received probiotics.

**Eosinophilic esophagatis:** Eosinophilic esophagatis (EE) is a disease characterized by swelling of the esophagus (the part of the body connecting the throat and the stomach) caused by an allergic white blood cell, the eosinophil. Symptoms of EE can range from severe heartburn, difficulty in swallowing, food impaction in the esophagus, nausea, vomiting and weight loss. Konieczna et al (2011) determined that a probiotic could induce Foxp3 T cells inhumans suffering from eosinophilic esophagatis due to milk allergens. Volunteers fed with B.infantis displayed selective increase in secretion of interleukins and enhanced Foxp3 expression in peripheral blood. B. infantis administration to humans selectively promotes immunoregulatory responses, suggesting that this microbe may have therapeutic utility in patients with inflammatory disease.

**Food labeling:** The Food Allergen Labeling and Consumer Protection Act (FALCPA) were passed by US Congress to ensure that there would be clearer labeling of food for the millions of people with food allergies. In India, as of January 01, 2006, all food products regulated by the FDA must be labeled in a specific way to identify the eight major food allergens: milk, egg, fish, crustacean shell fish, tree nuts, wheat, peanuts and soybeans. Some products carry ‘MAY CONTAIN’ warnings on labels to highlight that the food may contain minute traces of foods known to cause allergic diseases (Anon, 2009).

**CONCLUSION**
Many scientific reports clarify the defensive ability of probiotic bacteria against the allergic disorders developed due to egg, wheat, peanut, soy, blueberry, mushroom, seafood, milk, food additive and preservatives. As such probiotic are gaining importance because of the innumerable benefits, especially treating hypercholesterolemia, atopic dermatitis, eczema, gastrointestinal disorders and angioedema by strengthening the immune system. Probiotics also assists normal human body in regulating and maintaining immunological functions. Probiotic therapy has already made its way in the treatment of allergic diseases. So, in future prospect it promises to be an effective tool for allergy therapy, a careful selection of the probiotic agent, its dose standardization and a thorough knowledge of its beneficial effects over and above the toxic effects is desirable. Moreover, probiotics safety needs thorough scientific studies.

**REFERENCES**


Anon (2010) National Institute of Allergy and Infectious Diseases, Bethesda, U.K.  
Breitenbach, AM, Lukacs SL (2002). Three-year follow-up study of allergy in workers in a mushroom factory  