Effect of Prebiotics and Probiotics on Immune Status in Poultry: A Review

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Abstract: The use of antibiotics becomes important to treat and protect broiler from microbial diseases. There is a relationship between hazard of pathogenic diseases and antibiotic used in poultry production. The Prebiotics and probiotic are known as antibiotic alternatives in poultry. Prebiotics, are non-digestible feed ingredients that have the ability to enrich or support the growth of single or multiple species of beneficial organisms in the gastrointestinal tract. Prebiotcs include essential oils, plant extracts, spices, and organic acids. Probiotics are means as live microorganisms confer a health benefit on the host (broiler, turkey, and layers). Lactic acid bacteria, bacillus spores, and yeasts are the main groups of probiotic. The combination of probiotics and prebiotics is called synbiotics. Synbiotics are used for the synergistic improvement in reducing pathogen colonization in poultry by enhancing pre-harvest microbiological safety. Enhancement of the epithelial barrier, increase adhesion to intestinal mucosa, competitive exclusion of pathogenic microorganisms, and inhibition of pathogen adhesion production of antimicrobial substances are the major mechanisms of action of probiotics. Probiotics and prebiotics could modulate the systemic antibody response to antigens in chickens Moreover, the administration of probiotics results in the secretion of cytokines and changes in lymphoid cells in the chicken gut, which may lead to enhanced immunitytopathogenic diseases.
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Introduction

Poultry protein is the main favourite protein in most countries is the. Random use of antibiotics leads to increase microbial resistance **(Abd El- Hakim *et al*., 2009)**. Antibiotics are important for the elimination of diseases However, they also eliminate a large incidence of beneficial bacteria in the digestive system after treatment (**Dhama and Singh, 2010**)

Over use of antibiotics in poultry industry and its residue in poultry meat is harmful and has a toxic effect on consumers (**Kabir *et al*., 2004**). Elimination of antibiotics from poultry industry becomes an exhaustive search for alternatives to treat and protect broiler flocks from microbial diseases. The idea was produced when **Metchnikoff (1907)** studied the effect of "lactic acid bacteria" in fermented milk products. Intestinal bacteria played a role in the maintenance of health. Prebiotic supplementation resulted in improved body weight, feed conversion efficiency and carcass weight in broilers and subsequently improving productivity and increasing health benefits. (**El-Nagmy *et al*., 2000, and Hajati and Rezaei, 2010).**

The economic losses associated with enteric bacterial diseases can be summarized in; high mortality, loss of weight, poor feed conversion, the downgrading of carcasses, lowering fertility and hatchability as well as severe drop in egg production. *Colibacillosis, salmonellosis* and clostridial infections considered as the major bacterial poultry enteric problems that adversely affect gut integrity leading to severe economic losses in the poultry industry (**Abd El-Samee, 2001)**.

Prebiotics can be found in a variety of foods, including onions, and garlic, supplementary diets. They improve poultry resistance to enteric disease and promotes growth by several different means (**Mokhtari et. al., 2015**). Prebiotics affect- the immune system in poultry by stimulation of both cell-mediated and humeral immunity for better production of natural interferon/cytokines, increased macrophage, lymphocyte and natural killer (NK) cell activity, and increased immunoglobulin (IgG, IgM and IgA) (**Haghighi *et al*.,2005**).

Probiotics or direct feed microbial (DFM) are live microbial cultures, if administered in adequate quantity, result in desired health benefits in the host (**FAO, 2001**).

Probiotic are used in the poultry industry as alternative to antibiotics, it to have the ability to raise immunity during the management of microbial populations in the digestive system, to protect poultry from pathogenic bacteria and reduce the economic losses resulting from these diseases and modulate the immune system (**Amer *et al*., 2016**).

The mode of action of probiotics includes: competitive exclusion and antagonism, altering metabolism, improving digestion and feed intake related to increasing digestive enzyme and decreasing bacterial enzyme and ammonia production (**Ghasemi *et al.*, 2010**).

Competitive exclusion protect newly hatched chicks, turkey poults, quails and pheasants from infection (**Yang *et al.*, 2008**).

Synbiotic is a combination, of probiotics and prebiotics which act synergistically to result in the selective enrichment/survival of both exogenous bacteria (probiotic) and endogenous bacteria; This combination could positively modulate beneficial microbiota in gastrointestinal tract and reduce pathogens including *Salmonella*, *Campylobacter*, and Coccidia (*Eimeria acervulina* and *Eimeria tenella*) (**Baffoni *et al.*, 2012**). It was found that probiotic not only improves IgM antibody titer in broiler chickens but also improve antibody against specific against Newcastle disease virus (**Rowghanei *et al.*, 2007**) Also it was found that *Bacillius subtilis* probiotic improve bursal body weight ratio indicating immune stimulation (**Teo and Tan, 2007**).

In addition *Bacillius subtilis*can improves both bursal and spleen body weight ration indicating strong immune stimulation for both cellular and humoral immune response (**Willis *et al.*, 2008**).

It was found that probiotic not only improves IgM antibody titer in broiler chickens but also improve antibody specific against Newcastle disease virus (**Rowghanei *et al.*, 2007**).

Prebiotics

Prebiotics are dietary substances which increase the growth and/or activity of some beneficial intestinal bacteria. Prebiotics cannot be digested and not absorbed in the upper part of the digestive system. The site of action of prebiotics is the lower intestine, especially the colon, where short chain fatty acids (SCFAs) are produced after the prebiotics are fermented (**Patterson and Burkholder, 2003).**

Types of Prebiotics:

Prebiotics are small fragments of carbohydrates and are commercially available as oligosaccharides of galactose, fructose or mannose (**Biggs *et al.*,2007).** The most commonly used prebiotic preparations are fructo oligosaccharide (FOS), transgalac to oligosaccharide (TOS), inulin, gluco oligosaccharide, xylo oligosaccharide, isomal to oligosaccharide, soybean oligosaccharide, polydextrose, lacto sucrose **(Vulevic *et al.*, 2004)** Natural sources of prebiotics for vertebrates include chicory, onion, garlic, tomato and honey (**Chen and Chen, 2004).** Prebiotics were found to be effective against pathogenic bacteria like *clostreidiumperfringens* (C. *perfringens*) and *Escherichia Coli*. Dietary supplementation of chicory oligofructose and inulin improved feed conversion ratio, egg production and increasing egg weight per bird in white leghorn hens. (**Yang *et al.*, 2008).**

The principal mechanisms of prebiotics:

The principal mechanisms of prebiotics are immuno-modulation, include that

High fermentation activity and concentration of the SCFA are correlated with a lower pH, change in mucin production contribute to lower incidence of bacteria moving across the gut barrier nd help in increasing solubility of certain nutrients and suppression of pathogens. (**Teo and Tan, 2007and Lee and Salminen,2009)**. This phenomenon may inhibit some pathogenic bacteria and reduce colonization of some species like Salmonella, Campylobacter and E. coli, (**Chambers and Gong, 2011**).

Immune response Titer antibodies for Newcastle virus diseases Effect of diets supplemented with garlic powder was highly significant on titer of antibodies for Newcastle virus diseases (NVD) at different periods of 7, 14 and 21 days post vaccination (**Vetvicka and Sima, 2004).** Titer antibodies for avian influenza virus diseases (AIV) Results in show a trend similar to the effect of garlic powder on antibody titer against NVD. (**Kelly-Quaglian *et al.*,2003).** Inulin is the most common type of FOS.β2-1 Fructans, which include inulin (IN) and fructo oligosaccharides (FOS), fulfil the criteria for prebiotics. (**Gibson *et al.*, 2004**). IN is found naturally in a variety of plant foods such as barley, chicory, garlic, artichoke, leeks, onions and wheat. (**Roberfroid *et al.*, 2005**).

Probiotics:

Probiotics are, nontoxic and nonpathogenic organisms in nature, which when administered through the digestive route, are favorable to the host's health (**Beynen, 2006)**. Probiotics Stimulate the immune system and colonization of pathogenic strains of E-coli were reduced by native gastrointestinal microflora in the chicken and turkey (**Patterson and Burkholder.,2003)**.

Types of probiotic and Micro-organisms used:

There are several types of probiotic micro-organism available in market, they are varied according to ability of colonization inside intestinal tract, (**Mountzouries *et al.*, 2007).** Probiotic available commercially contains bacterial strains either identical to same micro-organisms that normal inhabitant in poultry intestinal tract such as *Lactobacillus casei*, *Lactobacillus lactis* and *Lactobacillus acidophilus*, while other contains strains differ from that normal inhabitant inside intestinal tract such as *Lactobacillus bulgaricus* and *Streptococcus thermophiles* (**Kabir, etal.2004)**.

Lactic acid bacteria:

Lactobacilli are a heterogeneous, non-sporing, rod shaped, catalase negative gram-positive bacteria and several species viz. *Lactobacillus casei*, *L. zeae*, *L. paracasei*, and *L. rhamnosus* have been commonly used as probiotic **(Jayaraman, et al 2015)**

Aspergillus oryzae (A. oryzae):

The efficacy of commercially available fermentation product from *Aspergillus oryzae* and *A. niger* as a nutritional aid in alleviating protein insufficiency (**Fuller, 1992)**. *A. oryzae* in broiler chickens has been shown to enhance the growth performance, significantly lower ammonia gas production, reduces serum cholesterol concentration in broilers and influenced microflora population in a beneficial manner **(Yoon, *et al*., 2004)**.

Yeasts:

The genus Saccharomyces has 4 different species. Saccharomyces cerevisiae has thousands of strains. Only a few S. cerevisiae's trains are used for poultry nutrition. Some of these strains have intestinal action result by: neutralization of certain bacterial toxins adherence of flagellate bacteria, due to the presence of mannose receptors (**Tollba, *et al*., 2004**).

Bacillus Species:

Several types of Bacillus (B) have antagonistic activity against *C. perfringens* due to the production of bacteriocins. For example, *B. thuringiensis* produces thuricin which is active against *C. perfringens*, **(Nisbet, 2002)**.

Mechanisms of Action of Probiotics:

Major Probiotic mechanisms of action include competitive exclusion of pathogenic microorganisms, enhancement of the epithelial barrier, increased adhesion to intestinal mucosa, and inhibition of pathogen adhesion, production of anti-microorganism substances and modulation of the immune system **(Ghareeb and Böhm, 2009)**.

Competitive exclusion:

The exact mechanism of action of probiotics associated with "competitive exclusion" or "bacterial antagonism" which refers to the physical blocking of pathogen colonization within the intestinal tract which are favourite sites of enteric pathogens by the probiotic bacteria **(Duggan *et al*., 2002**. Antibacterial substances produced like bacteriocins, lactocin, lactocidin, acidolin, acidophilin, nisin, organic acids (lactic and acetic acid), lactoferrin, hydrogen peroxide and lacto peroxidase inhibit pathogenic microbes (**Dhama *et al*., 2007)**.

Enhancement of the Epithelial Barrier:

Defenses of the intestinal barrier consist of the mucous layer, antimicrobial peptides, secretory IgA and the epithelial junction adhesion complex **(Ohland *et al.,* 2010)**. Once this barrier function is disrupted, bacterial and food antigens can reach the submucosa and can induce inflammatory responses, which may result in intestinal disorders, such as inflammatory bowel disease **(Farnell *et al*., 2006)**.

Increased Adhesion to Intestinal Mucosa:

Adhesion of probiotics to the intestinal mucosa is also important for modulation of the immune system and antagonism against pathogens adhesion has been one of the main selection criteria for new probiotic strains and has been related to certain beneficial effects of probiotics **(Juntunen, et. al. 2001)**.

Immune effect of prebiotics and probiotics in Poultry:

The bursa of Fabricius and the thymus regulate the development of the humoral and cellular compartments of the immune system, respectively. **(Amit, et al. 2004).**

Peripheral organs: spleen, gut-, bronchus-and head-associated lymphoid tissue (GALT, BALT and HALT, respectively) **(Christensen et al., 2002)**.

The positive effect of feeding diet containing probiotic on the immune response indicates the enhancement of the formulating bacteria on an acquired immune response exerted by T and B lymphocytes. *The production of the mucosal IgA response is dependent on other cytokines, such as transforming growth factor* ***(Nisbet* et al*., 1993).***

Prebiotics affect on the immune system in poultry via. Stimulation of both cell-mediated immunity and humeral immunity. with better production of natural interferon/cytokines, increased macrophage, lymphocyte and natural killer (NK) cell activity, and increased immunoglobulin (IgG, IgM and IgA) (**Haghighi *et al*., 2005)**.

Particularly through balanced control of anti-inflammatory and pro-inflammatory cytokines. Probiotics increase the number of lymphocytes and lymphoid cells in lamina propria and intraepithelial lymphocytes (IEL) in the small intestine and are found to inhibit the growth of infectious organisms **(Mason, *etal.,*2005)**.

Conclusion

Prebiotics, probiotics and synbiotics plays an important role in improving the productive and economic efficiency of poultry farms.

It is of great value to use probiotic or prebiotic as immune stimulant as it was found that it stimulate both cellular or humoral immune response including local immune response.

Some probiotics are responsible of production of proteins peptides which cause reduction in pathogenic bacteria of gut and producing antibodies thus giving immuntity against the diseases attack.

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