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SHORT REVIEW

Probiotics over antibiotics in the poultry industry

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Abstract

Background: Antibiotics have been used for centuries back when probiotics were not available for livestock and poultry industries. In recent decades, negative impacts of antimicrobial resistance (AMR) have been researched and positive consequences of probiotics have been revealed. The objectives of this short review are to focus on the benefits of probiotics over antibiotics including boosting immunity; putting eyes on the improvement of productivity and quality of products such as reduction of cholesterol levels; the importance of probiotics usage instead of antibiotics as a growth promoter; attention on reduction of AMR impact and lay emphasis on public health.

Methods: Secondary data and published peer-reviewed reports were used to write this short review.

Results: The use of probiotics is enormously beneficial over antibiotics. Published literature suggests using probiotics to enhance immunity levels, increase productivity and product quality, reduce AMR impact, and increase public health safety.

Conclusion: Probiotics can be included in poultry diets as an alternative to antibiotics which will address the AMR issues and thereby reduce public health hazards.

Keywords: Probiotics**;** antibiotics; poultry industry; AMR; growth promoter

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Introduction

Probiotics are live microorganisms associated with beneficial effects on gut health for humans and animals (FAO/WHO, 2001). Research and experiments show probiotics modulate the immune system by improving microbial balance in the intestine and work against pathogenic bacteria. For centuries, probiotics have been used for human consumption in different approaches such as "natural component or fermented food". Not only for human consumption, but there are also many probiotic products supplemented into animal feed. Those probiotics are applied to animal feed especially in poultry industries for better FCR, enhance the meat quality and egg production, and reduce mortality by improving immunity. The commercially raised chickens are exposed to various pathogens and it is essential to improve the feed efficiency for a healthy immune system with satisfying production. In the broiler industry, converting the feed into meat is the key role of poultry economics (Alam and Ferdaushi, 2018). To achieve the feed efficiency, many growth promoters have been used in feed formulation.

For decades, antibiotics were applied in feed as a growth promoter to upgrade the performance of livestock and poultry in a sub-therapeutic dose resulting in a negative impact as antibiotic residue that lodged in products. The continuous usage of huge antibiotics in feed and curing disease may lead to the distribution and the natural selection of antibiotic-resistant microorganisms (AMR), a global concern nowadays resulting in avoidance of antibiotics usage in many countries (Fahrenfeld *et al*., 2013). Nevertheless, the transmission of antibiotic resistant bacteria to humans is a certain consequence. So, most of the feed industries are searching for ways to upgrade the carcass quality and yield by using many ingredients in poultry and livestock feed. Many researchers and nutritionists have been suggesting probiotics as an alternative to antibiotics in poultry feed. Including a variety of microbial species such as *Bacillus, Bifidobacterium, Enterococcus, E. coli, Lactobacillus, Lactococcus, Streptococcus,* some undefined mixed cultures and a variety of yeast species have been used as probiotics. Therefore, the present review is focused with the objective to analyze benefits of probiotics over antibiotics in poultry feed in combating AMR.

Mode of Action

The microorganisms used as probiotics have the capability to manipulate the microflora of the gastrointestinal tract and help re-establish eubiosis (Busch *et al*., 2004). Many probiotics have been shown to produce some anti-pathogenic and antimicrobial substances ranging from small molecules to antimicrobial peptides (Busch *et al*., 2004). Though the in vivo effect is not demonstrated satisfactorily, most researchers have shown that the in vitro action of probiotics is to suppress the pathogenic bacteria in the GI tract of poultry.

Generally, the production of inhibitory substances like short-chain fatty acids, peptides, and other antimicrobial substances has a positive advantage such as changing the pH value without suppressing or killing residual and desirable gut flora. The production of an antimicrobial peptide known as Microcin J25 engineered by E. coli inhibits the colonization of Salmonella enterica in the GI tract of turkey (Forcus *et al*., 2017). Lactobacillus used as the supplementation of probiotics produces lactic acid and hydrogen peroxide that reduce the pH of the intestine and causes the death of microorganisms that are sensitive to an acidic environment. Lactic acid bacteria have another capability of rapid proliferation and some of them can secret mucopolysaccharides and other mucous substances by which they can make an intestinal barrier and include the substances as a line of defense. So, the pathogenic bacteria cannot bind with intestinal villi. Most of the Bacillus species which are used in probiotics are bacillus spores. After ingesting them with the feed they germinate and grow as vegetative cells and produce local intestinal immunity (Arasa *et al*., 2019). Yeast

strains such as *Saccharomyces cerevisiae* (e.g., bakery yeast) have been used to produce foods and in the production of some sorts of beverages. The yeast strains which are used as probiotics become active in the stomach and small intestine and then die off in the lower section of the small intestine. They can change the oxidation-reduction potential by using oxygen which can make a condition that is unfavorable to aerobic species (Busch *et al*., 2004).

Gut health and probiotics

Unlike other animals, poultry are subjected to many stressful conditions and highly exposed to pathogenic microorganisms. Bangladesh is prone to high prevalence of bacterial and other infectious diseases. The gastrointestinal (GI) infections are very common and major causes of poultry morbidity and mortality. In the GI tract, bacteria are most abundant and per gram content of caeca contains about 10^{10}-10^{11} microbes. Fungi and protozoa are the other gut inhabitant microbes (Albazaz and Buyukunal, 2014).

The gut microbes are the residual microorganisms coexisting with the ecosystem of gastrointestinal tract. There are some sorts of relationships or interactions between hosts and microbes. The composition of the intestinal flora can be changed with the ambient or under different physiological conditions. Equilibrium state of the ecosystem is defined as eubiosis. When both of the microflora and the host are equally benefited that is called symbiosis or good interaction, in the other situation when this relationship is disrupted that is called dysbiosis or bad interaction. The dysbiosis or bad condition happens when there are changes of nutritional bases for the microflora or with the compromise of symbiosis. Apart from nonpathogenic microbes, harmful members of the gut microflora may be involved in local or systemic infections, intestinal putrefaction, and toxin formation (Yasothai, 2017).

The inclusion of probiotics on poultry feed resulted in a numerical reduction in intestinal aerobes and fecal coliforms (Youssef *et al*., 2017). The successful colonization of probiotics is very important to inhibit the pathogenic bacteria in the gastrointestinal tract, and reduce the colonization of detrimental pathogens. Administration of multi-strain probiotics containing different *Lactobacillus* species and *Bacillus amyloliquefaciens*, prevents the establishment and spread of *Listeria monocytogenes* in the GI tract of broiler chickens (Neveling *et al.,* 2017).

The administration of commercial probiotic preparation formulated from several species like *Lactobacillus* and *S. cerevisiae* reduce the stress of *E. coli* K88 infected Hubbard broiler chicks and reduce the proliferation of *E. coli* in GI tract (Mohamed and Younis, 2018). Necrotic enteritis is one of the very common infections of the gastrointestinal tract in poultry which causes poor health and productivity. In case of Cobb 500, the inclusion of *Lactobacillus johnsonii* BS15 to the feed reduces the incidence of necrotic enteritis with the damage of villi (Wang *et al*., 2017). It has been suggested that higher villi length and deeper crypt may lead to higher nutrition absorption and secretion of digestive enzymes.

Effects on product quality

One study revealed that the probiotics had a significant effect on carcass weight, abdominal fat, and breast meat in broilers. The probiotics group resulted in higher carcass weight with low abdominal fat and higher percent of breast than the control group (Alam and Ferdaushi, 2018). In addition, the serum cholesterol level in the probiotics supplemented broiler and layer groups was lower than the control groups, comparatively (Saadia and Nagla, 2010; Mohan *et al*., 1996; Jouybari *et al*., 2009). Probiotics contribute to regulating serum cholesterol concentrations by de-conjugation of bile acids (De Smet *et al*., 1998).

According to Abdulrahim *et al.* (1996), *Lactobacillus acidophilus* reduces the cholesterol in the blood by de-conjugating bile salts in the intestine, thereby preventing them from acting as

precursors in cholesterol synthesis. Endo and Nakano, (1999) have shown a greater tendency of higher ratio of unsaturated fatty acids to saturated fatty acids in pectoral and thigh meat in broiler fed with probiotic-supplemented diet containing *Bacillus, Lactobacillus, Streptococcus, Clostridium, Saccharomyces* and *Candida species.* Mahajan *et. al*. (2000) mentioned that the scores for the sensory attributes of the meatballs' appearance, texture, juiciness, and overall acceptability were significantly ($p<0.001$) higher and those for flavor were lower in the probiotic (Lacto-Sacc) fed group. Numerous studies have shown that dietary probiotic treatment in poultry influences the histomorphology of muscle fiber.

It was reported that the administration of *Lactobacillus sakei* Probio-65 in broilers increased the villi height and crypt depth in jejunum (Park e*t al*., 2016). It has been observed from some studies that the modulation of immune responses in broilers fed with probiotics are different compared to other chicken administered control diets and antibiotics (Kabir *et al*., 2004). Supplementation of probiotic *Lactobacillus* in broiler diet enhances the intestinal immunity against coccidiosis by altering population of intestinal intraepithelial lymphocyte (IEL) expressing surface markers CD3, CD4, CD8, and αβTCR (Dalloul *et al*., 2003). Recent study revealed that probiotics product consists of *Lactobacillus fermentum*, and *Saccharomyces cerevisiae* increased the level of mRNA expression of TLR-2 and 4 in the foregut of the chickens compared to those administered with control diet and antibiotic (Bai *et al*., 2013). The dynamics of probiotics related to immune responses was evaluated by Kabir *et al.* (2004) and they observed that antibody production was upgraded in broilers fed with probiotics *Lactobacillus* compared to control chickens.

Ecological benefits

In the intestine, probiotics are partly broken down and digested like organic nutrients so, only a small proportion of probiotics are excreted in feces (Busch *et al*., 2004). Since all these microorganisms of probiotics are derived from nature, any negative impact is highly unlikely. In the poultry industry, people come into contact with probiotics in two ways, the workers of the feed industry and the farmer. The actions of probiotics are restricted to gastro-intestinal tract and do not lead to residues in any foodstuffs of animal origin, so they do not have any negative impact or health hazard for humans. Accordingly, nature and other animals are also getting rid of having any residual effects. Thus, probiotics have all the ways of impressive outcomes to humans, animals and environmental health.

Conclusion

Scientific evidence exists in support of the positive impact of probiotics in the poultry industry. Probiotics not only give the positive result as a growth promoter but also have a role in the increment of product quality. The literature also suggests improvement of immunity level due to probiotics usage. The probiotics can be included in poultry diets as an alternative to antibiotics in order to address the AMR issues.

Competing Interest

The authors declare that they have no competing interests.

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