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REVIEW ARTICLE

Role of nutraceuticals in gut health and growth performance of poultry

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Abstract The gut is a fundamental organ system which makes up two equally important functions, i.e., the digestion and host defence. To elicit the well-functioning and healthy gut, the dynamic balance of gut ecosystem is of importance. A wide range of factors related to diets and infectious disease agents seem to affect this balance, and subsequently affect the health status and production performance of the chicken. With the ban and/or reduction of the use of antibiotic growth promoters (AGPs) in poultry production, the alternatives to AGP are needed especially to preserve the balance of gut microbiota in chicken. This review provides a summary of the potentials and possible mechanisms of action of some alternatives to AGP (referred as nutraceuticals) in improving the gut microbial ecosystem and immune system as well as growth performance of poultry.

Contents

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1. Introduction

The high growth rate and feed efficiency are the two main targets in poultry production. A number of factors should be taken into consideration for the optimum performance of birds including genetic potential of the birds, quality of the diets, environmental condition and disease outbreaks. Apart from these mentioned-factors, gut health has recently been the subject of intense studies in poultry production (Rinttilä and Apajalahti, 2013). The gut is a pivotal organ system which mediates nutrient uptake and use by the animals. The gut is also a major site of potential exposure to environmental pathogens (Yegani and Korver, 2008). Hence, a well-functioning and healthy gut is the cornerstone of the optimum performances of the birds. When the gut function and health are impaired, digestion and absorption of nutrients are affected and thus the health and performance of birds will be compromised.

Besides responsible for the absorption of nutrients from the lumen, intestinal mucosa of broiler chicken plays an important role in providing an effective barrier between the hostile luminal content and the host internal tissues. In this notion, intestinal mucosa is an important determinant of gut health and performance of chicken (Rinttilä and Apajalahti, 2013). To support the intestinal mucosal barrier functions, the dynamic balance between the mucus layer, epithelial cells, microbiota and immune cells in the intestine is of importance (Schenk and Mueller, 2008). A number of factors associated with diet and infectious disease agents have been reported to affect this dynamic balance, and subsequently affect the health status and production performance of the chicken (Yegani and Korver, 2008). A subtherapeutic use of antibiotics has been widely practiced in poultry industry for decades to maintain the balance of ecosystem in the gut as well as to improve the growth performance of chicken (Huyghebaert et al., 2011). However, this practice has been questioned, given the increasing prevalence of resistance to antibiotics in chicken (Kabir, 2009). Hence, alternatives to antibiotics are needed in poultry industry to maintain the gut health and promote the performance of birds.

Of the factors that may be responsible for the gut health and performance of chicken, commensal microbiota in the gut seem to have pivotal roles as they may help to direct the development of gut structure and morphology, modulate the immune responses, offer protection from luminal pathogens as well as aid digestion and utilization of the nutrients (Rinttilä and Apajalahti, 2013). In their review, Yegani and Korver (2008) suggested that gut microbial profile can be affected by diet, in which the changes in dietary composition may result in the alteration of the microbial community in the gut. In addition to that, some foods or food ingredients have been reported to modulate the gut microbiota and immune system which may be beneficial for the chicken, referred as nutraceuticals (Huyghebaert et al., 2011).

The objectives of this review are to describe the potentials and possible mechanisms of action of some nutraceutical compounds (e.g., probiotics, prebiotics, synbiotics, organic acids, exogenous enzymes, polyunsaturated fatty acids [PUFAs] and phytobiotics) in improving the gut microbial ecosystem and immune system as well as growth performance of poultry. The applications of nutraceuticals for prevention and/or treatment of enteric infections in poultry are also briefly summarized in this review.

2. Gut microbiota, defence system and performance of birds

Similar to mammals, the immune system of birds is complex and composed of several cells and soluble factors that work together to produce a protective immune response (Yegani and Korver, 2008). It has been known that commensal gut microbiota is important inducers for the development and maturation of both innate defence mechanisms and adaptive immune responses of chicken (Muir et al., 2000; Haghighi et al., 2006; Brisbin et al., 2008). Based on the studies in mammals, specific commensal bacterial species may also have a vital role in inducing the accumulation of certain immune cell populations in the intestine (Kogut, 2013). For example, bacteria belonging to the phylum *Bacteroidetes* (i.e., *Bacteroides fragilis*) have been shown to be associated with the development of interleukin-17 (IL-17) producing T-helper cells (Mazmanian et al., 2005). Lactobacilli are a group of commensal bacteria that have long been known for their ability to activate the intestinal immune system and increase the resistance to diseases, in part through the release of low-molecular-weight peptides which induce immune activation (Muir et al., 2000). These bacteria have also been reported to produce a wide variety of short chain fatty acids (SCFAs), which are bacteriostatic for a subset of bacterial species either directly or by reducing pH of the intestinal environment, produce bacteriocins with microbicidal or microbiostatic properties and contribute to the colonization resistance against pathogenic microbes by modifying the receptors used by the pathogenic bacteria (Adil and Magray, 2012; Rinttilä and Apajalahti, 2013). Moreover, SCFAs produced by lactic acid bacteria (LAB) favour the renewal and barrier function of the gastrointestinal epithelium (Kogut, 2013).

The intestine contains both bacteria that are beneficial for the health, such as gram-positive lactobacilli and bifidobacteria, and potential pathogenic bacteria, such as *Clostridium* spp., *Salmonella* and *Escherichia coli*. It is generally accepted that a proper bacterial balance between the number of beneficial bacteria and bad bacteria in the intestine (at least 85% of total bacteria should be good bacteria) is vital for the host, and