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Combination of probiotic and phythobiotic as an alternative for antibiotic growth promoter for broilers chickens - a review

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Abstract

The use of antibiotic growth promoters (AGP) in feed can cause bacterial resistance in the intestines and also lead to the emergence of antibiotic residues in broiler chicken meat. This condition eventually resulted in the prohibition of using AGP in almost all countries in the world. Probiotics and phytobiotics are alternatives to AGP which are widely used by poultry producers today to maintain health and maximize the growth potential of broiler chickens. In addition to being used separately, probiotics and phytobiotics can be combined in their application to further maximize their role as an alternative to AGP for broiler chickens. This paper provides an in-depth review of the application of the combination of probiotics and phytobiotics as feed additive to improve production performance, gut ecology, immunity, antioxidative status and carcass quality of broiler chickens.

Keywords: *broilers, feed additives, growth promoters, phytobiotics, probiotics*

Introduction

In addition to improving feed quality, antibiotic growth promoter (AGP) has been commonly used by poultry producers to maximize the performance and health of broiler chickens. AGP is reported to be able to fight pathogenic bacterial infections (Mehdi et al 2018), improve intestinal ecology and morphology so that the digestion and absorption processes run optimally (Costa et al 2017). AGP can also maximize energy use for growth (Lin et al 2013; Mehdi et al 2018). Further, AGP can improve the digestive tract ecosystem so that the health of chickens can be maintained (Kim et al 2012; Lin et al 2014). On the other hand, the use of AGP in rations poses serious problems for consumers and has therefore been banned worldwide. This is because AGP administration can cause residue in feed and environment (Carvalho and Santos 2016; Gonzalez and Angeles 2017) so that it has a negative impact on human health (Er et al 2014; Murarolli et al 2014). Therefore, it is hoped that the poultry industry will no longer use AGP in broilers and look for other alternatives to increase livestock growth and chicken health.

Probiotics are feed supplements consisting of beneficial live microbes and can positively affect the host by improving the balance of intestinal microbes when given in certain amounts (FAO/WHO 2001). These live microorganisms commonly include *Lactobacillus*, *Bifidobacterium* and yeast strains which can produce bacteriocins to help inhibiting the growth of pathogenic bacteria (Al-Khalaifa et al 2019).

Phytobiotics are additives other than probiotics, which are traditionally used by farmers to improve the health condition of chickens. Phytobiotics are growth promoters derived from plants, spices and their derivative products, which have traditionally been used as feed additiv (Sugiharto 2016). Various kinds of plants can be used as phytobiotics and have properties with potential to increase feed consumption, improve feed conversion, and body wei gain and improve meat quality (Goodarzi and Nanekarani 2014; Li et al 2015; Mpofu et al 2016). Most of the active compounds contained in phytobiotics are secondary plant constituents (secondary metabolites), such as terpenoids, phenolics, glycosides and alkaloids (Huyghebaert et al 2011). Phytobiotics provide benefits to broiler chickens because they exhibit antimicrobial, antiviral, antioxidant, and various other biological activities (Wati et al 2015; Jarriyawattanachaikul et al 2016). Phytobiotics can also act as a digestive enhancer and can stimulate the secretion of endogenous digestive enzymes (Li et al 2015; Wati et al 2015).

Studies on the use of a combination of probiotics and phytobiotics as an alternative to AGP need to be known to see their effect on the productivity of broiler chickens. Therefore, this review will discuss the combination of

probiotics and phytobiotics as feed additive to improve production performance, gut ecology, immunity, antioxidative status and carcass quality of broiler chickens.

AGP application as an additive for broiler chickens

The use of antibiotics as a growth promoter in poultry feed was initially permitted in European Union member states over the past 50 years the aim was to promote growth rate, improve feed conversion, and reduce morbidity and mortality due to livestock diseases (Sugiharto 2016). Mehdi et al (2018) stated that the poultry industry uses antibiotics to improve meat production through increased feed conversion, growth rate promotion and disease prevention.

The use of AGP as a feed additive has shown an interaction between host nutrients and gut microflora. In addition, antibiotics effectively reduce the use of enzymes in feed. In general, giving AGP in broiler feed is to improve growth performance (Costa et al 2017), control diseases caused by pathogenic bacteria, and improve feed conversion of broilers (Singh et al 2013; Fasina et al 2015). However, concerns about the development of antimicrobial resistance and about the transfer of antibiotic resistance genes from animals to the human microbiota have led to the prohibition of using AGP in farm animals (Sweeney et al 2018; Tania et al 2018). In addition, the prohibition on the use of antibiotics is due to the fact that antibiotics have prophylactic activity and decrease health in broilers (Al-Khalaifah 2018).

Application of probiotics as additives for broiler chickens

The provision of animal feed containing probiotics as a feed additive to stimulate growth and prevent disease is not a novel dietary means. Probiotics are live microorganisms that are deliberately given to livestock with the aim of improving the balance of microbes in the digestive tract and reducing bad or pathogenic microbes such as *Escherichia coli*, *Salmonella*, and *Clostridium* and has a nutritional effect (Cheng et al 2014; Simon et al 2017). In broiler chickens, the most commonly used probiotics include *Lactobacillus* (*L. acidophilus, L. casei, L. farciminis, L. plantarum, L. rhamnosus*), *Bacillus* (*B. cereus var. Toyoi, B. licheniformis, B. subtilis*),*Enterococcus* (*E. faecium*), *Pediococcus* (*P. acidilactici*), *Streptococcus* (*S. infantarius*), several fungi including *Saccharomyces cerevisiae* and *Kluyveromyces* (Pandey et al 2015).

A number of researchers have reported the effect of probiotics on the productivity of broiler chickens. Pourakbari *et al.* (Pourakbari et al 2016) reported that probiotics can provide better body weight gain with a lower feed conversion ratio. The increase in body weight in broiler chickens caused by giving probiotics was also reported by Upadhaya et al (2015) and Islam et al (2014). Further, Hussein et al (2020) reported that the use of probiotics can prevent infection with necrotic enteritis, which can improve the harmful effects of broilers infected with *C. perfringens* in terms of performance, feed efficiency, meat quality and carcass characteristics. Peng et al (2016) stated that the use of *L. plantarum* had a positive effect on the growth of broiler chickens, reduces the content of *E. coli* in the cecum, and increases the number of lactic acid bacteria in the cecum and ileum. Probiotics have also been reported to ameliorate the negative effects of heat stress in broilers (Sugiharto et al 2017).

Phytobiotic applications as additives for broilers

Phytobiotics are natural bioactive compounds derived from plants that can stimulate appetite, help endogenous secretions such as enzymes, and have antimicrobial activity so that they can improve the performance and health of farm animals (Wati et al 2015; Jarriyawattanachaikul et al 2016). Phytobiotics can be used to replace the role of AGP as a growth promoter for broiler. This is due to the large number of active ingredients found in plant extracts, such as antioxidants, immunostimulants, and antimicrobials (Li et al 2015; Wati et al 2015; Jarriyawattanachaikul et al 2016). In previous studies, several bioactive compounds from plants have been identified as potential candidates that can stimulate the growth of beneficial bacteria such as *lactobacilli* and *bifidobacteria* and inhibit the growth of pathogenic bacteria (Fasina et al 2015; Hussein et al 2020).

The results of previous studies showed that phytobiotics are very beneficial when given to broiler chickens because they can inhibit pathogenic bacteria, improve intestinal health, increase antioxidant status and can improve digestive function, as well as improve chickens immune functions (Murugesan et al 2015; Jarriyawattanachaikul et al 2016; Nobakht et al 2016). Research conducted by Fallah et al (2013) to evaluate the effect of artichoke leaf meal (*Cynara Scolymus* L.) and menthe extract (*Mentha piperita*) as a phytobiotic in broiler chickens showed that there was a decrease in high-density lipoprotein (HDL) and low-density lipoprotein (LDL) concentrations. The use of nutmeg meat flour (*Myristica frangrans Houtt*) and clove leaves (*Syzygium aromaticum L*) as phytobiotics can reduce feed costs and reduce the use of antibiotics during the rearing of broiler chickens (Sapsuha et al 2019). However, the use of phytobiotics as feed additives on the growth performance of

broiler chickens can vary depending on the biological factors of the plant itself, such as plant species, location for cultivation and conditions during harvesting, as well as storage conditions such as light, temperature, and storage time (Sugiharto 2016).

Combination of probiotics and phytobiotics as additives for broiler chickens

The combination of probiotics and phytobiotics has been studied as an alternative to antibiotics in broiler feed for the last few years (Ren et al 2019). *In vitro* research using combination of probiotics and phytobiotics conducted by Prakasita et al (2019) shows that phytobiotics can support the growth of probiotic bacteria. Several studies have also reported that probiotics and phytobiotics are more efficient when used together (simultaneously) rather than applied separately (Yuanita et al 2019). The results of previous studies conducted by Denli et al (2003) shows that giving phytobiotics, probiotics, and their combination can improve performance and result in better carcass weight. Ferdous et al (2019) reported that the use of a combination of phytobiotics and probiotics in broiler ration can improve growth performance, the number of beneficial bacteria productions, and reduce the coliform bacteria population. Further, Hossain et al (2012) reported that adding a combination of *Alisma canaliculatum* and probiotics consisting of *L. acidophilus, L. plantarum, E. faecium, B. subtilis, B. coagulans,* and *S. cerevisiae* to the feed can improve growth performance of broiler chickens.

Effect of combination of probiotics and phytobiotics on production performance

A number of studies have shown that the combination of probiotics and phytobiotics in broiler chicken feed can improve production performance. In terms of production performance, giving the combination of probiotics and phytobiotics resulted in increased body weight and better feed conversion ratio (Denli et al 2003; Wahyuni et al 2019). Yuanita et al (2019) reported that the combination of probiotics and phytobiotics in feed increased body weight of broilers when compared to the control group, but there was no significant difference in feed consumption and conversion. Different from the previous authors, Daneshmand et al (2011) did not report a significant increase in body weight in the combination of probiotic and phytobiotic group compared to either single or control administration. In addition, Kim et al (2007) reported no synergistic effect on growth performance when plant extracts and *Lactobacillus* were mixed and fed to broilers. This difference can be explained by the different types of probiotics and phytobiotics used, because different types of probiotics and phytobiotics may have different effects (Sugiharto 2016).

Effect of combination of probiotics and phytobiotics on gut ecology

Probiotics and phytobiotics have been reported to have a positive impact on the microbial ecosystem in the digestive tract so that it can improve the health and function of the digestive tract of chickens (Sugiharto 2016; Clavijo and Florez 2017). Recent studies reported that the use of probiotics and phytobiotics together has better effects on gut health and function in broiler chickens. Ren et al (2019) reported that the combination of probiotics (*L. salivarius* and *L. agilis*) and phytobiotics (commercial phytogenics containing the active ingredients such as carvacrol, cinnamaldehyde, and eugenol) can provide more energy for the growth of beneficial bacteria in the gut such as *bifidobacteria* and *Lactobacillus* sp. compared to giving probiotics and phytobiotics individually. The results of other studies indicate that the combination of ginger and turmeric extract (4 mL per 1 liter of drinking water), and *Lactobacillus* sp. can reduce the number of pathogenic bacteria in the intestines of broiler chickens (Risdianto et al 2019). However, Chang et al (2019) reported a mixture of multi-strain probiotics (*L. acidophilus, L. fermentum, L. casei,* and *P. acidophilus*) and *Gardeniae fructus* increases the concentration of short chain fatty acids (SCFA) in the cecum, thereby promoting better intestinal development, and can increase the number of beneficial bacteria (*Lactobacillus* and *Bifidobacterium*), and inhibit pathogenic bacteria (*E. coli* and *Clostridium perfringens*) in the intestines of broiler chickens. The reason why the combination produces a better impact is because phytobiotics can support the growth of probiotic bacteria and also play a role in inhibiting pathogenic bacteria (Prakasita et al 2019). In addition, the carbohydrate content, especially oligosaccharides from herbal plants, can be a good substrate for the growth of probiotic microbes (Rahminiwati et al 2014) so that probiotics work better.

Influence of combination of probiotics and phytobiotics on immune system

The combination of probiotics and phytobiotics has been reported to increase the immune response in broiler chickens (Kim et al 2016). In line with the studies above, the research results of Risdianto et al (2019) showed that broiler chickens that were given a combination of ginger and turmeric extracts and *Lactobacillus* sp. through drinking water had higher weight of bursa of fabricius and thymus than the control group. In addition, other research shows that giving*Scutellariae radix*, *Gardeniae fructus* combined with*Lactobacillus* in feed can increase

broiler chickens' immunity to *Salmonella* infection (Hsu et al 2016). The results of the research by Ahmed et al (2014) showed that orange peel waste combined with multispecies probiotic bacteria such as*B. subtilis, L. acidophilus, Enterococcus faecium* and *S. cerevisiae* in broiler feed can improve immune status which is marked by an increase in serum immunoglobulin (Ig) M concentrations.

The study by Jung et al (2010) showed that the use of herbal plants fermented with probiotics (*S. cerevisiae*, *B. subtilis* and *L. acidophilus*) in feed could increase immune activity in broiler chickens and increase resistance to *Salmonella Gallinarum* in infected broilers. Therefore, its use can be a good candidate as an alternative feed supplement to reduce antibiotic use through increased immune activity and disease prevention. The results of other studies indicate that the combination of ginger and turmeric extract (4 mL per 1 liter of drinking water), and *Lactobacillus spp.* increases immune system endurance of broiler chickens (Risdianto et al 2019).

The combination of probiotics and phytobiotics consisting of*Ginkgo biloba* + *Punica granatum* and *Camelia sinensis* + *Punica grantum* fermented with probiotic microorganisms (*Lactobacilli* + *Saccharomyces* sp .) has been shown to be effective in increasing immunity which is indicated by an increase in serum IgM in broiler chickens (Kim et al 2016) Wahyuni et al (2019) also reported that the combination of probiotics and phytobiotics had an immunomodulatory effect so that can increase the antibody titer against Newcastle disease vaccine. The mechanism related to the combination of probiotics and phytobiotics can increase the immune response in broiler chickens, i.e. probiotics can neutralize enterotoxins and stimulate the immune system (Jung et al 2010; Risdianto et al 2019), and phytobiotics can increase the immune response in broiler chickens and can act as immunostimulant substances, and protect intestinal tissue from microbial attack (Sugiharto 2016; Mehdi et al 2018; Ferdous et al 2019). Eventually, optimal intestinal development can support the development of the immune system in the intestine.

Influence of combination of probiotics and phytobiotics on antioxidative status

Literature has shown that the combination of probiotics and phytobiotics was capabl of improving the antioxidative status of broiler chickens. Yuanita et al (2019) reported that a mixture of Dayak onion and *L. acidophilus* extract increased the concentrations of superoxide dismutase (SOD) and reduce malondialdehyde (MDA) in the blood of broilers. For note, SOD is an enzyme that activates the dismutase reaction of superoxidic anions to form hydrogen peroxide (Ivanova and Ivanov 2000), while MDA is the end product of lipid peroxides, especially polyunsaturated fatty acids (PUFA) in the body and decomposition products of amino acids, carbohydrates, pentose, and hexose (Łukaszewicz et al 2016; Skovorodin et al 2019).

Bioactive content in phytobiotics and *Lactobacillus sp.* plays an important role in increasing the production of antioxidant enzymes. Risdianto et al (2019) reported that a combination of ginger and turmeric extract (4 mL per 1 liter of drinking water) and *Lactobacillus* sp. increases glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD) in the blood which indicates the best antioxidant status in broiler chickens. The GSH-Px is an enzyme that contains selenium which can reduce H_2O_2 and organic hydroperoxides into water/alcohol and oxygen (Pisoschi and Pop 2015).

The increase in antioxidant status in broiler chickens due to the provision of the combination of probiotics and phytobiotics was due to the synergistic effect of the two components, of which probiotics play a role in increasing oxidative enzymes in broiler chickens because probiotic bacteria have antioxidant activity (Djezzar et al 2014). Likewise, bioactive substances in phytobiotics may act as an antioxidant which synergistically triggers antioxidant activity in the body of broilers (Li et al 2015; Jarriyawattanachaikul et al 2016).

Influence of combination of probiotics and phytobiotics on meat quality

The combination of probiotics and phytobiotics in broiler rations has been revealed to improve meat quality of broiler chickens. The study by Djezzar et al (2014) documented that the combined probiotics (*P. acidilactici*) and herbal plants (*Y. schidigera* and *Trigonella foenum graecum*) produced lower abdominal fat in broiler chickens than the control group. Further, the study of Yuanita et al (2019) show that the combination of *L. acidopilus* and Dayak onions can increase total phenols, flavonoids, and antioxidant activity of broiler chicken meat and reduce the mass of meat cholesterol.

The use of a combination of herbs and probiotics has also been reported to increase crude protein content, reduce crude fat content, and can reduce lipid oxidation in broiler chicken meat (Sarker et al 2010; Hossain et al 2012). The low value of lipid oxidation indicates that there is an increase in oxidative stability in broiler meat. Lipid oxidation is one of the main mechanisms for decreasing the quality of meat products through changes in taste, color, texture, and nutritional value (Ura et al 2008). The mechanism by which the combination of probiotics and

phytobiotics could improve the quality of meat is because probiotics produce enzymes that can increase nutrient absorption in the digestive tract and detoxify toxic substances so that they have the potential to increase feed digestibility, which in turn increases nutrient content, especially meat protein (Popova 2017). As previously explained, the multi-strain probiotic mixture increases the concentration of short chain fatty acids (SCFA) in cecum (Chang et al 2019). SCFA consists of acetate, butyrate, and propionate. Propionate is an inhibitor of the lipogenesis process in the liver, so that meat fat content decreases (Beylot 2005). Further, the bioactive substances contained in phytobiotics can inhibit lipid oxidation and degradation of meat pigments, thus helping to stabilize the color of the meat and can improve the overall sensory and nutritional quality of meat (Shah et al 2014). Furthermore, Gello et al (2012) stated that the bioactive substances from plants are effective in inhibiting protein oxidation in meat, thereby improving the quality of the meat.

Conclusions

The combination of probiotics and phytobiotics can be used in broiler chicken feed as a substitute for AGP to improve production performance, gut ecology, immunity, antioxidative status, and improve the quality of broiler chicken meat. The in-depth study is needed to further elucidate the functionalities of combination of probiotics and phytobiotics in broiler feed.

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