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# Probiotic *Lactobacillus sp.* Improved Performance of Broiler Chicken: A Review

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**ABSTRACT**
Probiotic *Lactobacillus sp*. is considered a potential resource for improving the performance of broiler chicken in Indonesia. Administration of *Lactobacillus sp*. Probiotics could increase the Average Daily Gain (ADG) and body weight of broiler chickens by increasing intestinal villi permeability, so that nutrient absorption could be optimal. Use of *Lactobacillus sp*. in the ration is often combined with other probiotics, prebiotics, phytoadditives, and organic acids to support the feed intake and feed conversion ratio. *Lactobacillus sp*. also able to produce various bioactive compounds such as the enzyme manase which could be in symbiosis with *mannan-oligosaccharides* (MOS) to increase the bodyweight of broiler chickens and bacteriocins that against pathogenic bacteria such as *Salmonella typhimurium*, *Staphylococcus aureus* and *Bacillus cereus*. Probiotic metabolic activity of *Lactobacillus sp.* could suppress the growth of pathogenic bacteria by creating an acid digestive environment. In addition, immunity and hematological conditions such as erythrocytes, hematocrit, leukocytes, MCV, MCH, and MCHC were maintained well by *Lactobacillus sp.* supplementation in the ration. This review aims to highlight the potential of probiotic *Lactobacillus sp* to modulate broiler microbiome and metabolic status to enhance performance and health.

**Keywords:** Broiler chicken, *Lactobacillus sp.*, Production performance, Probiotics

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## INTRODUCTION

Antibiotics have been used as ingredients in animal feed mixtures in Indonesia since 1946 with the aim of improving digestibility, growth, and health of livestock. However, its use as a growth driver has the potential to stimulate resistance (Krisnan *et al*., 2019). Therefore, the Indonesian government has issued a regulation concerning the prohibition of the administration of antibiotic growth promoters in Law no. 18/2009 jucto No.41 / 2014 concerning Animal Husbandry and Animal Health which states the prohibition of the administration of feed mixed with certain hormones and/or feed additive antibiotics with the classification of veterinary drugs listed in the Minister of Agriculture Regulation No.14 / Permentan / PK .350/5/2017. The prohibition of antibiotics in feed is also strengthened by the issuance of MOA No. 22/2017 concerning Registration and Distribution of Feed, which requires a statement not to use antibiotic growth promoters in feed formulas produced by producers. In the previous study by Cardinal *et al*., (2019) found that withdrawing antibiotic growth promoters from the broiler diet increased production costs, which in turn increased the price of poultry meat. Even though the consumption of chicken meat in Indonesia is about 6.1 kg per capita on average, this value is still lower than in other countries. Therefore, efforts are needed to replace the role of antibiotics growth promoters with an affordable, safe, and natural additive in the feed.

Currently, alternatives used for antibiotics include probiotics, prebiotics, competitive exclusion, enzymes, and organic acids. The administration of probiotics is expected to be a candidate for AGP substitution. Probiotics are non-pathogenic living organisms present in some foods which have positive effects on the health of the hosts if they enter the body in sufficient amounts (Mousavi *et al.*, 2018). The most selected probiotics are gram-positive bacteria belonging to *Bacillus*, *Enterococcus*, *Lactobacillus*, *Pediococcus*, and *Streptococcus*. It is not only bacteria that are used as probiotics; yeast and fungi have been used, such as *Saccharomyces cerevisiae* and *Kluyveromyces* (Selaledi *et al*., 2020).

The presence of *Lactobacillus sp*., a common microbiota in the chicken broiler gastrointestinal tract, is essential to maintaining the ecological balance in the microbiota. The supplementation of probiotics to feed could maintain the balance of microflora in the digestive tract and inhibit pathogenic bacteria, increase digestive enzyme activity, reduce ammonia production, increase feed intake and digestion, neutralize enterotoxins and stimulate the immune system. Isolate *Lactobacillus sp*. could be taken from native Indonesian chicken which has great potential (Yulianto and Lokapirnasari, 2018).

### Probiotic Classification

Probiotics are classified by observing the similarities of qualities, such as physical characteristics, metabolic needs, and metabolic end products. These similarities grouped into one genus, while the special characteristics that exist in one individual and do not exist in another individual will become the name of the species. The general classification of probiotics could be seen in table 1.

Table 1. The general classification of probiotics

| Genus | Species | e.g., Strain | Ref. |
|---|---|---|---|
| Lactobacillus | murinus | Ar3 | Harimurti *et al*., 2010 |
| | | CR147 | Harimurti *et al*., 2010 |
| | plantarum | BS22 | Zeng *et al*., 2018 |
| | | B1 | Peng *et al*., 2016 |
| | acidophilus | D2 | Cesare *et al*., 2020 |
| | | A3B3 | Sa'diyah *et al*., 2020 |

| | | | |
|---|---|---|---|
| | casei | CECT 4043 | Sethiya NK, 2016 |
| | | Shirota | Sethiya NK, 2016 |
| | salivarius | I72 | Damayanti *et al*., 2012 |
| | reuteri | C1 | Mookiah *et al*., 2014 |
| | | C10 | Mookiah *et al*., 2014 |
| | | C16 | Mookiah *et al*., 2014 |
| | agilis | JCM 1048 | Lan *et al*., 2004 |
| | | LA73 | Ren et al., 2019 |
| | paracasei | L1 | Xu *et al*., 2019 |
| | fermentum | CCM 7514 | Sˇefcova´ *et al*., 2021 |
| | rhamnosus | TB1 | Bouzaine *et al*., 2005 |
| | | JYLR-005 | Liu *et al*., 2021 |
| Streptococcus | thermophilus | Kp2 | Harimurti and Ariyadi , 2014 |
| | | Kd2 | Harimurti and Ariyadi , 2014 |
| Pediococcus | acidilactici | Kd6 | Harimurti *et al*., 2010, |
| | | DSM 20284 | Damayanti *et al*., 2014 |
| | pentosaceus | Db9 | Konosonoka *et al*., 2015 |
| | | TMU457 | Konosonoka *et al*., 2015 |
| | | NP6 | Khochamit *et al*., 2020 |
| Bacillus | subtilis | DSM 32315 | Whelan *et al*., 2019 |
| | | 29784 | Jacquier *et al*., 2019 |
| | | PB6 | Jayaraman *et al*., 2017 |
| | | DSM17299 | Knap *et al*., 2011 |
| | | B21 | Musa *et al*.,2019 |
| Saccharomyces | cerevisiae | CECT 1891 | Pizzolitto *et al*., 2013 |
| | boulardii | CNCM I-1079 | Massacci *et al*., 2019 |
| Aspergillus | oryzae | GB-107 | Hong *et al*., 2004 |
| | | 3.042 | Feng *et al*., 2007 |

Among the various kinds of microorganisms used as probiotics, lactic acid bacteria (LAB) are the type of microorganism that is most widely used. Lactic acid bacteria are bacteria that could produce lactic acid as a result of the fermentation of carbohydrates. Lactic acid works to prevent the development of pathogenic microorganism; therefore, it has the potential as probiotics (Purwandhani and Rahayu, 2003). The dominant lactic acid microbiota in broiler GIT is *Lactobacillus reuteri*, *L. salivarius*, L. *agilis*, and *L. acidophilus*, about 10.19 × $10^9$ CFU/ml in the small intestine and $10^{10}$ to $10^{11}$ cell / g in the large intestine (Manin *et al*., 2010).

**Effect Probiotic *Lactobacillus sp.* on ADG and Final Body Weight**

Wahyudi and Hendraningsih (2007) showed that lactic acid *Lactobacillus casei* could increase intestinal villi permeability, nutrient adsorption, and digestibility, maintain the health of broiler chickens and resulted enzymes capable of digesting fiber, fat, and protein. Therefore, the nutrients absorbed properly to support the muscle development of broilers. These benefit mechanisms directly affect average body weight and feed conversion (Sari and Akbar, 2019; Pertiwi *et al.,* 2019). In similar research, the combination of 18% protein with 1.2% dahlia tuber inulin and 1.2 ml of *Lactobacillus sp.* was able to result intestinal villi height and improve protein digestibility (Purbarani *et al*., 2019). By increasing the height of the intestinal villi, the absorption of feed nutrients could be optimized well.

*Lactobacillus sp.* found in the natural digestive system of chickens produced the enzyme manase which selectively bind to *manna-oligosaccharides* (Selaledi, *et al*., 2020). Administration of *mannan-oligosaccharides* (MOS) in broilers could increase daily body weight by 4-8% (Sinovec *et al*., 2005). Various bioactive compounds produced by probiotic *Lactobacillus sp*. could be seen in table 2. In Contrast, Aurora *et al*., (2020) reported that administration prebiotic *fructooligosaccharide* (FOS) with a combination of *Lactobacillus achidophilus* as much as 2 ml/kg of the ration could increase bone strength and length but has not increased weight gain to chicken bones. The tibia and femur bone weight did not increase significantly, presumably due to there has been a change in the structure of the bone constituent matrix due to increased absorption of Ca and protein, but it has not yet affected bone weight. *Lactobacillus sp*. could be combined with other beneficial microorganisms as probiotics. Mahajan *et al*., (2000) reported a significant increase in the weight of viscera, fresh carcass weight, cold storage carcass weight, and carcass percentage of broilers fed with probiotics combination of *Lactobacillus sp.* and *Saccharomyces sp*.

The administration of multistrain probiotics between *Lactobacillus murinus*, *Streptococcus thermophilus*, and *Pediococcus acidilactici* improved small intestine morphology and integrity in broiler chickens by the develop villi height and depth of intestinal crypt (Harimurti and Sutriswati, 2009). Supplementation of $10^8$ CFU/ml/bird daily of these types of probiotics could give a significant effect of weight gain increasing within 28 days (Harimurti *et al*., 2010).

Table 2. Various bioactive compounds produced by probiotic *Lactobacillus sp.*

| Bioactivities | Functions | References |
|---|---|---|
| Malic acid | Against *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Bacillus cereus* | Baserisalehi *et al*., 2017 |
| Lactic acid | | |
| Acetic acid | | |
| Phenyllactic acid | Control foodborne pathogens, spoilage organisms, and contaminating yeasts | Kantachote *et al*., 2010 |
| Nisin | Forms pores in the cytoplasmic membrane in pathogenic bacteria | Gabriela *et al*., 2016 |
| Lactocin | Antimicrobial effect against *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus*, and *Bacillus cereus* | Majid *et al*., 2017 |
| Reutericyclin | Antimicrobial effect | Mu *et al*., 2018 |
| Manase | Selectively bind manna-oligosaccharides | Selaledi *et al*., 2020 |
| Galactose | Enhanced their anti-inflammatory effects on macrophages | Chen *et al*., 2019 |
| Lipoteichoic acids | Reduces leaky gut and inflammation | Wang *et al*., 2019 |
| Serine | Anti-inflammatory response in dendritic cells from IBD patients | Al-Hassi *et al*., 2014 |
| Threonine | | |

**Effect Probiotic *Lactobacillus sp.* on Feed Intake and Feed Conversion Ratio**

Probiotics supplementation in feeds could maintain microflora balance in the digestive tract and inhibit pathogenic bacteria, increase digestive enzyme activity, decrease ammonia production, improve feed intake and digestion, neutralize enterotoxins and optimize the immune system (Manin *et al*., 2010). Zhui *et al*., (2018) showed that administration of probiotic *Lactobacillus acidophilus* in the ration, increased body weight, decreased FCR, and reduced mortality. In order to increase the effectiveness of prebiotics and probiotics in improving the productivity of broilers, prebiotics and probiotics are often used together. The combination of prebiotics and probiotics is known as a symbiotic. Prebiotics are a source of indigestible carbohydrates that affect the host by selectively stimulating the growth of some bacteria in the colon. (Selaledi *et al*., 2020). Nutrients that are proposed to have prebiotic potential include fructans, oligofructose, inulin, fructooligosaccharides, galactan, galactooligosaccharides, resistant starch, pectin, fiber components, and milk oligosaccharides (Bird *et al*., 2010). The content of these nutrients is found in plant extracts that are widely cultivated in Indonesia such as garlic (*Alium sativum*). Experiments conducted by Sunu *et al*., (2020) showed that using 4 ml of garlic extract with the supplementation of *Lactobacillus acidophilus* at a ratio of 100: 1 ml was able to produce a feed consumption of 2908.92 ± 1.24 g and feed conversion of 1.24 ± 0.04 g within 35 days.

Naik *et al*., (2000) evaluated the effect of different probiotics between *Lactobacillus acidophilus*, Saccharomyces cerevisiae, and their combination) on the performance of broilers and reported that supplementation of *Lactobacillus* to the basal diet at 0.05% improved feed efficiency in broilers as compared to the control group. The combination of several probiotics *Lactobacillus plantarum*, *Lactobacillus bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Bifidobacterium bifidum*, *Streptococcus thermophilus*, *Enterococcus faecium*, and *Bacillus subtillis* ($10^9$) yields a good feed conversion on broiler (Rocha *et al*., 2010). Harimurti *et al*., (2010) showed the administration of *Lactobacillus murinus*, *Streptococcus thermophilus*, and *Pediococcus acidilactici* about 108 CFU /ml/bird daily provides a feed intake of 1359.72 g/bird with a feed conversion rate of 1.93 within 28 days.

Experiments conducted by Pasi *et al*., (2018) for six weeks resulted in a feed intake of 3285.87 ± 7.39 g and FCR 2.28 ± 0.04 using a combination probiotic between *Lactobacillus sporogenes* + live yeast 0.02% + 0.2% g /chick/pen. The administration of *Lactobacillus* could also be combined with organic acids. Treatment of organic acids and probiotics leads to better performance in the examined properties in male Ross 308 broilers compared to the feed containing antibiotics especially for feed intake, weight gain, FCR, and abdominal fat percentage (Beheshti *et al*., 2009).

**Effect Probiotic *Lactobacillus sp* on Animal Health**

Normal flora microorganisms in the digestive tract will compete with each other for nutrition and attachment sites in the gastrointestinal ecosystem. Pathogenic bacteria could initiate infection disease if they have dominated the population of the total microorganisms in the digestive tract by suppress beneficial bacteria activity, increase pH and release a toxin (Sunu *et al*., 2020). The immune system of broilers in the early stage has not developed well and susceptible to bacterial infections caused by *Campylobacter jejuni*, *C. perfringens*, *Salmonella enterica*, and *Escherichia coli* (Ohimain and Ofongo, 2012). Therefore, it suggested intestinal floral microbes balance need to be maintained to support the health of chickens to start growing fast in the starter phase.

Lactic acid bacteria as probiotics in the digestive tract could inhibit the activity and growth of pathogenic microbes through the production of organic acids, hydrogen peroxide ($H_2O_2$), and bacteriocins (Taheri *et al*., 2009). A similar study by Sari and Akbar (2019) found that lactic acid bacteria not only producing bacteriocin but also resulted physiological effects on broiler health, as a feed supplement, drugs (such as natural antibiotics), therapeutic effects (such as hypo cholesterol and antihypertensive, prevention of diarrhea). In addition, some types of lactic acid bacteria could lower the pH level of the digestive tract, which disturb pathogenic bacteria metabolism due to unsuitable environment condition for them (Mousavi *et al*., 2018). The inhibition mechanism of bacteriocin occurred in two phases. The first phase was bacteriocin absorption of specific and nonspecific receptors on target bacterial membrane cells. During this phase, the bacteriocins became sensitive, especially to proteolytic enzymes. A second phase was irreversible and involves lethal changes in the sensitive strains (Damayanti *et al*., 2012).

The administration of *Lactobacillus sp.* probiotics could restore the amount of microflora in the digestive tract and suppress the coliform population (Hamid *et al*., 2014). *L. reuteri*, *L. salivarius*, or *Lactobacillus sp*. treatment could inhibit the pathogen bacterial such as *Enterococcus faecalis*, *Enterococcus faecium*, *Listeria monocytogenes*, and *Salmonella sp*. (Lima *et al*., 2007). Meanwhile, *L. fermentum* and *L. rhamnosus* were able to fight against *E. coli* and *S. pullorum* (Torshizi *et al*., 2008).

In the similar research by Olnood *et al.* (2015), reported that the administration of multi strain Lactobacillus spp. probiotic in broilers diet elevated the number of total Enterobacteria and anaerobic bacteria in small intestine especially in the ileum and caeca, and the amount of lactic acid bacteria in the caeca, due to the ability to co- and auto aggregate. Commonly, microorganisms demonstrating a high auto-aggregation potential result a good adhesion to the mucus (Jha *et al.,* 2020). One of the indications of immunity organ health improvement of broilers was indicated by the increase of bursa fabricius weight as the central of lymphoid organ (Purbarani *et a.l*, 2019). The size of the bursa of fabricius correlates with the high number of B cells maturated and produced by the chicken. Zhang *et al*., (2012) reported that administration of the probiotic *Lactobacillus paracasei* resulted higher percentage of lymphoid organs (Fabricius bursa and spleen) on the poultry to support their health and production performance.

A similar study by Hidayat, (2020) showed that supplementation *Lactobacillus paracasei* about of 5 ml/day increased the weight of immune organs such as 0.194% in the bursa of Fabricius, 0.20% in the spleen, and 0.32% in the thymus of the total weight of the lymphoid organs, It also improves hematological level significantly as health biomarker of broilers, include erythrocyte (2.67 x 106 mm3), hematocrit (29.2%), leukocytes (21.1 x 103 / mm3), MCV (109.82 - 111.53 fl), MCH (32.77 - 34.11 Pg), and MCHC (29.96% - 31.14%).

*Lactobacillus sp*. which is used as a fish meal fermentation as broilers feed could increase serum lipid performance in broiler chickens. Sumarsih *et al*., (2010) showed that the administration of the fermented fish meal with *Lactobacillus sp*. as much as 4 – 8% in the ration reduced the average LDL cholesterol (66.86) and triglycerides (82.60). Cholesterol status is highly related to health conditions. There are two types of cholesterol, which give a different impact on health, is LDL cholesterol provides negative effects, while HDL cholesterol has a positive impact on health, while triglycerides whose density is reduced will turn into LDL (Sumarsih *et al*., 2010).

## CONCLUSION

The administration of *Lactobacillus sp*. As probiotics have a beneficial effect on production performance and Animal Health. The application of *Lactobacillus sp*. could be an alternative of natural growth promoters to replace AGP in the broiler chicken's feed.

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