



Performance of Broiler Chickens in Open House Cages with Additional Probiotic Nutrition

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Abstract | To maximize the productivity and efficiency of broiler farming, one way is to add additional feed or probiotics as additional feed. The aim of this research is to analyse performance of broiler chickens in open house cages with additional probiotic nutrition. The research method used is experimental based with a post-test design only for the control group. This study used a completely randomized design (CRD). 30 broiler chickens were randomly assigned to three treatments (P0, P1, and P2) at least six times in each group. The results obtained in this research are giving lactic acid bacteria (LAB) with a concentration of 108 CFU/ml to broiler chickens infected with *Escherichia coli*, research that has been carried out shows that this shows a better performance index. By adding lactic acid bacteria at a concentration of 108 CFU/ml on a farm scale of 2000 heads per period, the contribution margin can cover all fixed costs, so the road remains viable.

Keywords | Broiler chicken performance, Open housed, Probiotics, CRD

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INTRODUCTION

To meet livestock protein needs, especially chicken, production and consumption of poultry products increases every year. Compared to closed houses, most breeders choose open cages because temperature and humidity can be regulated by adding curtains, good air circulation, and lower costs (Abdurrahman *et al.*, 2022; Susanti, 2023). However, poultry farms that use the open house method continue to experience many problems, especially colibacillosis which is caused by infection with the pathogenic bacteria *Escherichia coli*. Colibacillosis disease in poultry is

usually caused by avian pathogenic *E. coli* (APEC) (Kathayat *et al.*, 2021).

Colibacillosis is usually spread through the mouth through contaminated feed, drinking water, or feces *E. coli* (Fancher *et al.*, 2020). Colibacillosis is usually spread through the mouth through contaminated feed, drinking water, or feces *E. coli*. These bacteria can spread through the bloodstream and cause disease in several organs, such as septicemia, enteritis, omphalitis, air sacculitis, peritonitis, pericarditis, and oovitis. (Kittler *et al.*, 2020). With the discovery of *E. coli* positive in chick deaths due to oovitis which in-

creased from 28.4 to 31.4 percent proves that farmers are really losing money due to *E. coli* in poultry. One way to deal with infection *E. coli* is by adding probiotics to the feed ration or drinking water (Akanbi *et al.*, 2022).

But basically, apart from the risks mentioned above, managing poultry in open cages also has advantages, such as relatively cheap operational costs for building open cages and maximizing ventilation due to the relatively high intensity of wind and sunlight. The weakness of open cages is greatly influenced by external environmental conditions such as heat, humidity and wind, especially in Indonesia, where the tropical climate often experiences extreme weather changes. In the highlands, temperatures are very cold and humidity is high, while in the lowlands, temperatures are very high and the winds are quite strong (Susanti *et al.*, 2022).

In addition to environmental factors, the commercial use of antibiotic growth promoters (AGPs) has been restricted due to drug resistance to intestinal pathogenic bacteria, including *Escherichia coli*. The presence of antibiotic residues in feed and the environment endangers human and animal health (Carvalho and Santos., 2016 and Garcia *et al.*, 2021). To maximize the productivity and efficiency of broiler farming, one way is to add additional feed or probiotics as additional feed. This is in accordance with research findings Monino *et al.*, (2023), which showed that the addition of probiotics affected broiler chicken performance, including feed conversion, mortality, decreased feed consumption, increased body weight, and increased broiler carcass percentage (Nam *et al.*, 2022). Probiotics, living organisms, have the ability to benefit the health of their recipients when used in appropriate amounts (Maftei *et al.*, 2024). Probiotic bacteria, which are found in many human and animal digestive tracts, help restore the balance of intestinal microflora and reduce pathogenic bacteria (Corcionivoschi *et al.*, 2020).

Probiotics can help develop beneficial gut microflora populations and eliminate pathogenic bacteria. One of the pathogenic bacteria that causes a decrease in broiler production is *E. coli*. Lactic acid bacteria are beneficial for secreting several enzymes that aid in food digestion (Fioramonti *et al.*, 2003). Lactic acid bacteria (LAB) are very beneficial for humans and livestock. These microorganisms have the ability to balance the microflora of the digestive tract, promote health, and protect against pathogenic bacteria such as *E. coli*.

The use of lactic acid bacteria probiotics has great practical significance for the poultry industry. Economically, the use of probiotics can reduce medication costs and improve production efficiency. By improving poultry health, probi-

otics can reduce mortality and disease rates, thereby reducing financial losses caused by poor health conditions. After consumption, probiotics deliver many lactic acid bacteria to the digestive tract. These microorganisms are known to alter the gut environment and deliver enzymes and other beneficial substances into the gut (Anjana and Tiwari., 2022). Supplementation of *L. acidophilus* or mixed *Lactobacillus* cultures in chickens significantly increased ($P < 0.05$) amylase levels after 40 days of feeding (Anjana and Tiwari., 2022).

Therefore, additional food consisting of lactic acid bacteria originating from the livestock's digestive tract is needed to maintain the balance of the digestive tract. *Lactobacillus* sp., one of the lactic acid bacteria in the digestive tract of livestock, is very important for maintaining the ecological balance of bacteria in the digestive tract (Hakim *et al.*, 2023). *Lactobacillus reuteri*, *L. salivarius*, *L. agilis*, and *L. acidophilus* are the dominant lactic acid bacteria in the digestive tract of broiler chickens, and the balance of these lactic acid bacteria has an impact on the health and performance of broiler chickens. (Marchwińska and Gwiazdowska, 2022).

Lactobacillus plantarum is a lactic acid bacterium of the lactobacillaceae family and lactobacillus genus. This non-motile gram-positive bacterium measures $0.6\text{--}0.8\text{ }\mu\text{m} \times 1.2\text{--}6.0\text{ }\mu\text{m}$ and has antagonistic properties against microorganisms such as *Staphylococcus aureus*, *Salmonella*, and gram-negatives that cause food spoilage. *Lactobacillus plantarum* can absorb salt, produce acid quickly, and its final pH is 5.3–5.6 (Garcia *et al.*, 2021).

Lactobacillus plantarum is a native isolate isolated from the intestinal mucosa of healthy broilers. Its characteristics include tolerance to bile acids, low pH, fast growth rate, and high latic acid production (Liu *et al.*, 2023). According to (Yi *et al.*, 2020), *Lactobacillus plantarum* antimicrobials containing bacteriocins can stop the growth of pathogenic bacteria such as *Escherichia coli*, *Salmonella typhimurium*, and *Staphylococcus aureus*.

Lactobacillus plantarum produces bacteriocins, protein compounds that kill bacteria, and are helpful in the production of lactic acid, which is the largest producer of hydrogen peroxide compared to other lactic acid bacteria (Rocchetti *et al.*, 2021). *Lactobacillus plantarum* bacteria also produce bacteriocins, which have a bactericidal effect on sensitive cells and can cause rapid cell death even at low concentrations. *Staphylococcus aureus* bacteria and gram-negative bacteria can be killed by bacteriocins produced by *L. plantarum* (Sukmawati *et al.*, 2022). *L. plantarum* can also produce bacteriocins, which act as antibiotics (Rahmah *et al.*, 2017).

Lactobacillus casei bacteria can improve poultry health. These bacteria have the ability to improve the function of the digestive tract by producing lactic acid, which can reduce the number of harmful bacteria present in the digestive tract (Sari and Akbar., 2019). By reducing harmful bacteria in the digestive tract, the digestive tract absorbs nutrients better.

Lactobacillus casei can kill many harmful bacteria, including *E. coli*, Staphylococcus, Salmonella, Vibrio, Listeria, and Shigella (Raheem *et al.*, 2021). Some *Lactobacillus* bacteria have the ability to produce antimicrobial substances known as bacteriocins, such as acidolin, acidophilin, and lactosidin. In previous studies, probiotic *L. casei* was shown to increase broiler feed consumption. Probiotics in nutrition can increase enzyme activity and aid digestion, which means more efficient nutrient conversion and better feed digestibility (Zhang *et al.*, 2022).

Due to high operational costs, probiotics containing lactic acid bacteria are expected to increase the digestibility of chickens in open pens. The use of sophisticated equipment and high electricity requirements makes weakening closed house cages more difficult and requires more skills in cultivation management (Abun *et al.*, 2024; Teguh *et al.*, 2023). In this study, *Lactobacillus acidophilus*, *Lactobacillus casei*, and *Lactobacillus plantarum* were the main probiotics used.

Pojok Village, Wates Subdistrict, Kediri District, is an area where the majority of the population depends on the local poultry farming industry. Despite being a major producer, the industry is faced with various challenges, such as inconsistent feed quality, frequent poultry diseases, and declining productivity. Therefore, research on the use of probiotics in poultry in Pojok Village is of great relevance. By applying probiotics, it is expected to improve the health and productivity of poultry, thus potentially having a positive impact on the sustainability of the local poultry farming industry in the region.

Astuti *et al.* (2015) found that the addition of probiotics can improve broiler performance, including reducing feed consumption, protein, feed conversion, mortality, and increasing body weight, weight, and carcass percentage. In accordance with the description above, the purpose of this study was conducted to determine the performance index of broiler farms that added probiotic lactic acid bacteria (*Lactobacillus plantarum*, *Lactobacillus casei* and *Lactobacillus acidophilus*) to broilers infected with *Escherichia coli*.

PROBIOTICS

Over the years the word probiotic has been used in several different ways. Originally used to describe a substance produced by one protozoa that is stimulated by another pro-

tozoa (Ravindran and Abdollahi, 2021), but was later used to describe animal feed supplements that have a beneficial effect on the host animal by influencing its intestinal flora (Ravindran Abdollahi., 2021). Karunaratne *et al.* (2021) defines probiotics as “cultures of certain live microorganisms (mainly *Lactobacillus* spp.) implanted in animals to ensure effective establishment of populations of beneficial and pathogenic organisms in the intestine” Faiqoh *et al.* (2023) then provides a unique definition of probiotics as “live microbial feed supplements that exert beneficial effects on the host animal by improving its gut microbial balance”. The US National Grocers Association presents, probiotics (live-fed microbes) as a natural source of live microorganisms and these include bacteria, fungi and yeast (Karunaratne *et al.*, 2021). According to the definition currently adopted by FAO/WHO, probiotics are: “live microorganisms which, when administered in sufficient quantities, confer a health benefit on the host” (Karunaratne *et al.*, 2021). More precisely, probiotics are live microorganisms that are non-pathogenic and non-toxic, which, when administered via the digestive route, will benefit the health of the host (Karunaratne *et al.*, 2021).

It is believed by most researchers that there is an unstable balance between beneficial and unfavourable bacteria in the digestive tract of normal, healthy, non-stressed birds. If there is balance, birds will work at maximum efficiency, but if stress occurs, beneficial flora, especially lactobacilli, have a tendency to decrease in number and overgrowth of unfavourable flora is likely to occur. These events may predispose to real disease, for example diarrhoea, or be sub-clinical and reduce production parameters such as growth, feed efficiency, etc. The protective flora that grows in the intestine is very stable but can be influenced by several dietary and environmental factors. The three most important ones are excessive hygiene, antibiotic therapy, and stress. In the wild, chickens would receive complete gut flora from their mother's faeces and would consequently be protected from infection. However, commercially raised chickens are hatched in clean incubators and usually do not contain organisms commonly found in chicken intestines. There is the influence of microbiological shell contamination which can affect the characteristics of the intestinal microflora. In addition, gastric HCl secretion, which begins on day 18 of incubation, has a major impact on microflora selection. Therefore, the use of probiotic supplementation immediately at birth is more important and useful in avian species than in other animals. Chickens are an extreme example of a young animal that cannot have contact with its mother or other adult animals and, therefore, would most likely benefit from supplementation with microbial preparations designed to restore the protective gut microflora (Gill, 2023).

When given in certain amounts, probiotics, namely

non-pathogenic microorganisms, can help the health and physiology of a person or their host. According to Latif *et al.*, (2023), probiotics are beneficial live microbial supplements that maintain the balance of microorganisms in the digestive tract and help the host. Probiotics can increase the capacity of poultry digestive organs to digest crude protein, so that poultry can get maximum benefits from the feed they consume (Ravindran and Abdollahi, 2021).

If probiotics are included in animal feed rations, the population of pathogenic bacteria will be reduced and feed nutrients will be better digested in the small intestine (Al-Shawi *et al.*, 2020). This fact is in line with opinion Karunaratne *et al.* (2021), which states that the addition of probiotics to chicken rations can increase crude protein digestibility, reduce digesta viscosity, and increase enzyme production β -glucanase in all parts of the digestive tract (Faiqoh *et al.*, 2023).

Yi *et al.*, (2020) talks about how probiotics help improve the digestive tract in the following ways: (1) produce vitamins and substances that the body cannot get enough of, (2) encourage the production of enzymes such as cellulase, protease, and alpha-amylase, (3) encourage enzyme reactions that can neutralize toxic substances that are ingested or made by the digestive tract, and (4) suppress reactions that produce toxins and metabolites that are carcinogenic (cancer-causing).

MECHANISM OF ACTION

Increased colonization resistance and/or direct inhibitory effects against pathogens are important factors by which probiotics have reduced the incidence and duration of disease. Probiotic strains have been shown to inhibit pathogenic bacteria both in vitro and in vivo through several different mechanisms. The way probiotics work in poultry includes: (i) maintaining normal intestinal microflora through competitive exclusion and antagonism (Faiqoh *et al.*, 2023); (ii) changing metabolism by increasing digestive enzyme activity and decreasing bacterial enzyme activity and ammonia production (Khaksefidi and Rahimi, 2022); (iii) improve feed consumption and digestion (Nurliana *et al.*, 2023); and (iv) stimulate the immune system (Song *et al.*, 2012).

Probiotic and competitive exclusion approaches have been used as a method to control endemic and zoonotic agents in poultry. In traditional terms, competitive exclusion in poultry means the use of natural microorganisms in the gut in chicks and birds ready to be placed in brooder cages Song *et al.* (2012) first applied this concept when they tried to control a severe outbreak of *S. infantis* in Finnish broiler flocks. In their study, it was determined that a very low Salmonella challenge dose (1 to 10 cells in a plant) was

enough to initiate salmonellosis in chickens. Additionally, they determined that in the first week after hatching, the chicks were most susceptible to Salmonella infection. Use of the Lactobacillus strain did not result in protection, and this forced them to evaluate unmanipulated gut bacterial populations from adult chickens that were resistant to *S. infantis*. On oral administration of this undefined mixed culture, adult-type resistance to Salmonella was achieved. This procedure became known as Nurmi or the concept of competitive exclusion.

A competitive exclusion approach in inoculating adult microflora in day-old chicks successfully demonstrated the impact of gut microbiota on gut function and disease resistance (Anjana and Tiwari, 2022). Although competitive exclusion fits the definition of a probiotic, the competitive exclusion approach instantly provides the chick with mature gut microbiota versus adding one or more bacterial species to an existing microbial population. Inoculating day-old chicks with competitive exclusion cultures or more classic probiotics serves as a good model to determine how these microorganisms work and the efficacy. Because of the susceptibility of day-old chicks to infection, this practice also has commercial importance. Using this model, a number of probiotics Anjana and Tiwari (2022) has been shown to reduce colonization and shedding of Salmonella and Campylobacter. Competitive exclusion is a very effective measure to protect chicks, turkey poult, newly hatched quail and pheasants, and possibly also other game birds, against Salmonella and other enteropathogens (Anjana and Tiwari, 2022).

Once consumed, probiotics deliver many lactic acid bacteria to the digestive tract. These microorganisms are known to change the intestinal environment and deliver enzymes and other beneficial substances into the intestines (Anjana and Tiwari, 2022). Supplementation of *L. acidophilus* or mixed Lactobacillus cultures in chickens increased significantly ($P < 0.05$) amylase levels after 40 days of feeding (Anjana and Tiwari, 2022). These results are similar to the findings Anjana and Tiwari (2022), who reported that the inclusion of probiotics (a mixture of several strains of *Lactobacillus* spp. and *Streptococcus faecium*) resulted in significantly higher carbohydrase enzyme activity in the small intestine of piglets. Lactobacilli that colonize the intestine can secrete enzymes, thereby increasing intestinal amylase activity (Roza *et al.*, 2022). It is known that probiotics alter pH and gastrointestinal flora to support increased intestinal enzyme activity and nutrient digestibility (Roza *et al.*, 2022). The effect of *Aspergillus oryzae* on macronutrient metabolism in laying hens has been observed (Roza *et al.*, 2022), whose findings may have practical relevance. They postulated that the active amylolytic and proteolytic enzymes present in *Aspergillus oryzae* may influence ingested

nutrients. Likewise, it is reported that the increase in dry matter digestibility is closely related to the enzymes released by yeast. In addition, probiotics can contribute to improving the health status of poultry by reducing ammonia production in the intestine.

Probiotics is a general term, and products may contain yeast cells, bacterial cultures, or both that stimulate microorganisms capable of modifying the gastrointestinal environment to support health status and improve feed efficiency (Raheem *et al.*, 2021). The mechanisms by which probiotics increase feed conversion efficiency include changes in intestinal flora, increased growth of non-pathogenic facultative anaerobic bacteria and gram-positive bacteria that form lactic acid and hydrogen peroxide, suppression of the growth of intestinal pathogens, and improved digestion and nutrient utilization (Raheem *et al.*, 2021). Therefore, the main results of using probiotics include increased growth (Raheem *et al.*, 2021), reduction in mortality (Raheem *et al.*, 2021), and increased feed conversion efficiency. These results are consistent with previous experiments by Raheem *et al.*, (2021), who observed an increase in feed conversion efficiency with the supplementation of probiotics into the diet.

Manipulation of the gut microbiota through administration of probiotics influences the development of the immune response (Raheem *et al.*, 2021). The exact mechanisms mediating the immunomodulatory activity of probiotics remain unclear. However, probiotics have been shown to stimulate different subsets of immune system cells to produce cytokines, which in turn play a role in the induction and regulation of immune responses. Stimulation of human peripheral blood mononuclear cells with *Lactobacillus rhamnosus* strain GG in vitro resulted in the production of interleukin 4 (IL-4), IL-6, IL-10, tumour necrosis factor alpha, and gamma interferon. Other studies have provided confirmatory evidence that Th2 cytokines, such as IL-4 and IL-10, are induced by lactobacilli. The result of Th2 cytokine production is the development of B cells and immunoglobulin isotype switching required for antibody production. Production of mucosal IgA responses depends on other cytokines, such as transforming growth factor β . Importantly, various species and strains of lactobacilli are capable of inducing the production of transforming growth factor β , although to varying degrees. Probiotics, especially lactobacilli, can modulate systemic antibody responses to antigens in chickens (Raheem *et al.*, 2021).

MATERIALS AND METHODS

ETHICAL CONSIDERATION

The research was approved by animal care and used com-

mittee, Gadjah Mada University Research Ethics Commission No:011621/1/LPPT/III/2024 has provided an ethical certificate for the use of experimental animals in this research

STUDY PERIOD AND LOCATION

This research was carried out from December 2023 to February 2024 and was located in Pojok Village, Wates District, Kediri Regency. Research effective practices for dealing with high temperatures and humidity in chicken farming in tropical areas. For example, using a proper ventilation system, providing optimal lighting, and controlling the temperature of the cage with the help of advanced technology such as the use of fans or air conditioning systems.

IN VIVO EXPERIMENT

The type of research carried out was real experimental research, with a post-test design only for the control group. This study used a Completely Randomized Design (CRD). 30 broiler chickens were randomly assigned to three treatments in each treatment so that the total population used was 90 broiler chickens (P0, P1, and P2) at least six times in each group.

P0 Control / without probiotic in the drinking water

P1 Drinking water added by probiotic 10^8 CFU/ml in the drinking water

P2 Drinking water added by probiotic 10^6 CFU/ml in the drinking water

At least six total replications were required for each of the three groups; In the research carried out, ten replications were used for each treatment group, so a minimum of thirty experimental animals were required. In a closed and ventilated room, one day old broiler chickens are kept in cages with drinking water and feed. For each group of chickens, the cage measures one square meter and is equipped with an air filter to avoid noise and other industrial pollution. This cage size is a standard size used for laboratory animals that are kept by considering research observation variables.

The samples used in this study were broilers (*Gallus domesticus*) cobb strain that weighed 40 grams, healthy and vaccinated. Broilers were treated with probiotic lactic acid bacteria (*Lactobacillus plantarum*, *Lactobacillus casei* and *Lactobacillus acidophilus*) with concentrations of 106 CFU/ ml and 108 CFU/ ml. *Eserichia colli* bacteria were included in the feed (without antibiotics) at a dose of 106 cells/kg BW. Broiler rearing was conducted for 35 days.

STATISTICAL ANALYSIS

The study divided the research samples into three treat-

ment groups. Group P1 received 10^8 CFU/ml of *Escherichia coli* bacteria, and group P2 received 10^6 CFU/ml of *Escherichia coli* bacteria. Group P0 did not receive probiotics. The indicator of the dependent variable in this study is the performance index of broilers comparing (average body weight x percentage of mortality) with (average harvest age x feed conversion) X 100%. The results of the study were averaged and data analysis using ANOVA test and Duncan test was used, each with a confidence interval of $p < 0.05$.

Data analysis was carried out with ANOVA tes followed by test Duncan with a confidence interval of ($p < 0.05$)

RESULTS AND DISCUSSION

Performance index calculation is a qualification used to measure maintenance success. The performance index value is calculated based on body weight ready for slaughter, age at harvest, feed conversion, and the total percentage of live chickens during rearing. The IP value is determined by how efficiently feed is used and how well the chicken performs. Below we will present the results of data processing related to the broiler chicken performance index.

Table 1: Broiler performance index.

Treatment	Mean $\pm$ SD
P0 (Control + <i>E. coli</i>)	351.07a + 27.04
P2 (Probiotic 106 + <i>E. coli</i>)	357.16a + 40.44
P1 (Control 108+ <i>E. coli</i>)	416.67b + 56.28

Source: Data Processing Results (2024)

The results of the normality test for carcass weight data with $p > 0.05$ indicate that the data is included in the normal data group, which allows further testing. The results of the one-way ANOVA statistical test and the Duncan test showed that group P1 had significant differences compared to groups P2 and P0. The average value of group P1 is 416.67^b, the value of group P2 is 357.16^a, and the value of group P0 is 351.07^a.

The performance index values for rearing broiler chickens are divided into five groups. The performance index value in group P1 (416.67^b) is considered special because it exceeds 400, and the performance index value in group P0 (351.07^a) has a value range of 326-350 which is considered good, and the performance index value in group P2 (357.16^a) has The value range of 351-400 is considered good. Broilers with probiotic dose 10^8 had a numerically higher IP. This context is in line with the statement made by Yulianto *et al.* (2021) that the ideal broiler production index is 200; The higher the production index, the better the performance of broiler chickens.

The performance index value in the P1 group (416.67^b) was higher than the P0 (351.07^a) and P2 (357.16^a) groups because the average body weight, percentage of mortality and feed conversion were more efficient in the probiotic administration of 108. This is in line with Raheem *et al.*, 2021 mentioning the effect of using probiotics including increased growth, decreased mortality and increased feed conversion efficiency. This finding is in line with previous research by Raheem *et al.* (2021), which showed an increase in feed conversion efficiency when probiotics were added to the diet.

Probiotics to increase livestock growth and production. The increase in chicken performance index can be caused by improved digestibility and absorption of nutrients in the digestive tract. This is because probiotics produce enzymes, propionic acid, butyric acid, bacteriocytes, and lactic acid, which function to repair the intestinal mucosa and villi and maintain digestibility and absorption of nutrients. In addition, they prevent harmful bacteria (Ikhwana *et al.*, 2024).

Probiotics are used in chickens to replace antibiotics. Antibiotics increase the productivity of chickens by killing pathogenic bacteria in the gut so that beneficial bacteria can thrive. In contrast, probiotics increase the number of bacteria in the gut, but only the beneficial ones. Probiotics produce bacteriocins and short-chain organic acids (lactic, acetic and propionic) to change the condition of the intestinal tract, especially the hydrogen potential (pH) to acidic. This improves gastrointestinal immunity. Probiotics and these endogenous microbes can inhibit the development of harmful microbes so that beneficial microbes can compete for entry into the intestinal epithelium. By attaching to the intestinal mucosa, they can block pathogens, enhance immunity and improve nutrient absorption (Bonnefous *et al.*, 2022; Susanti *et al.*, 2022).

According to Hariono *et al.* (2023), the performance index improvement factor refers to chicken body weight, feed conversion, depletion and length of rearing. Giving probiotics to broiler chickens can improve their growth, conversion rates, and also increase the availability of vitamins and other feed substances. This is also supported through opinions (Paly, 2023), that the use of probiotic microbes that produce cellulase enzymes can use feed that is high in crude fibre and helps in the digestive process so that crude fibre can be used for tissue growth and increasing the body weight of poultry.

Giving probiotics can have an impact on the efficiency of feed use so that the chicken feed conversion rate becomes low. Providing probiotics to chickens improves chicken digestion. This is in accordance with the statement Ayivi *et al.*, (2020) In fact, probiotics increase the activity of

digestive enzymes so that feed absorption can be more complete through a wider absorption area because probiotics can have an effect on intestinal anatomy, namely the intestinal villi become longer and their density becomes denser. The process of absorbing the results of digestion is on the surface of the villi which have many microvilli (Chen *et al.*, 2024).

Treatment P0 is 351.07^a showing no difference with P2 (357.16^a), however P0 (351.01^a) and P2 (357.16^a) show numerical differences indicating the performance index figure for P0 is lower than P2. This is because giving probiotics at this dose is not effective in inhibiting the growth of digestive tract microbes. The higher the concentration of probiotics given can cause the higher levels of bacteria in them, so that livestock can be more efficient when consuming their feed (Sari and Akbar, 2019).

Probiotics will not function properly if the dose of probiotics given is not appropriate and the composition of the microflora when probiotics are given is not correct. Effective probiotic dosage also depends on the strain used and the characteristics of that strain. If probiotics do not work optimally, then nutrient absorption will not be optimal, which will impact broiler chicken production (Bonnetfous *et al.*, 2022). There are several factors that also influence the effectiveness of probiotics, namely storage factors and inappropriate methods of administering probiotics. These various factors have been controlled in the research, so that the accuracy of the dose influences the results.

Fixed costs are costs that do not affect the total production produced (Susanti *et al.*, 2022). Fixed costs on a research scale consist of cage depreciation costs, cage equipment depreciation costs and labour costs. The lifespan of the cage and cage equipment is calculated as 60 months, so the depreciation costs for the cage and cage equipment are IDR 15,500 and IDR 3,500. The labour cost for one worker for a month is IDR 700,000. Total fixed costs amount to IDR 512,000. These fixed costs are divided into three treatment groups, namely groups P1, P2 and P0. Cage depreciation costs for each treatment amount to IDR 5,500, depreciation costs for cage equipment amount to IDR 500 and labour costs amount to IDR 216,300. The total fixed costs for each treatment are the same, namely IDR 210,500.

Fixed costs on a farm scale consist of annual depreciation costs for cages with rental drums along with cage equipment and capital interest costs. Capital is obtained from loans to banks with interest of 5% per year so that in a year, the interest expense is IDR 6,000,000. The cost of depreciation of the cage per year is IDR 8,250,000 with an estimate of keeping broiler chickens in one year for six periods so that the depreciation value of the cage for one

period is IDR 3,221,343. Capital interest in a period is IDR 700,000. The total fixed costs for one period of raising broiler chickens with a population of 2000 are IDR 3,221,343.

Variable costs are costs that change according to the results produced (Hariono *et al.*, 2023). Production costs in a business must be calculated for fixed and variable costs (Teguh *et al.*, 2023). Variable costs on a research scale consist of the costs of DOC, feed, drinking water, husks, electricity, probiotic lactic acid bacteria, *Escherichia coli* bacteria culture and labour costs. The overall variable costs amount to IDR 922,800 which are divided into three parts, namely costs in groups P1, P2 and P0. The cost in the control group (P0) was IDR 541,100, while in the group of experimental animals given P1 probiotics it was IDR 538,600 and in the P2 group it was IDR 544,600. This difference in value is caused by variable costs, including the amount of feed and probiotics provided. The price of feed is obtained from the total feed consumption multiplied by the price of feed per kilogram.

Total costs are all costs incurred throughout the production process. Total costs are fixed costs plus variable costs. The results show that total costs are lowest at P1, this is due to more efficient feed costs at P2 and P0. The highest total costs in P2 were due to the high cost of feed and the cost of lactic acid bacteria probiotics. In line with the research carried out Fancher *et al.*, (2020) reported that probiotics are very useful with low production costs and can be widely used in various animals.

The research results of 10 broilers/ treatment were obtained from sales of broiler chickens minus costs during the production process, each treatment had different losses. In group P1 (giving probiotics 10⁸ CFU/ml) the loss was IDR 506,450, followed by group P0 (not given probiotics) a loss of IDR 344,150 and the highest loss by P2 (giving probiotics 10⁶ CFU/ml) was IDR 367,340. Details of the scale of the 2000 head farm earned a profit of IDR 15,221,000.

Contribution margin is a helpful medium that managers can use to analyze profit levels in a production. The bigger the contribution margin you get, the bigger the profit you get (Susanti *et al.*, 2022). The highest contribution margin value is the value of the P1 treatment group (giving probiotics 10⁸ CFU/ml), amounting to IDR 90,230 followed by the P0 group (control group) amounting to IDR 52,110 and the lowest value is the value in the P1 treatment group (giving probiotics 10⁶ CFU/ml) amounting to IDR 30,340. The contribution margin value on a livestock scale is IDR 24,323,000, which is 33% of the total revenue value.

Application of probiotic lactic acid bacteria can benefit the effectiveness of the digestive tract and improve the performance index of probiotic broilers. Giving probiotics can provide a favorable return on investment for farmers, including the cost of investment in probiotics can be compensated for by a faster increase in broiler body weight and increased feed efficiency. This agrees with Raheem *et al.*, 2021, stating that the use of probiotics increases growth, reduces mortality, and increases feed conversion efficiency.

Probiotic feeding can be easily integrated into broiler farm management programs through the application of probiotics through the chickens' drinking water efficiently without disrupting the farm routine. Challenges in probiotic administration in commercial farming include the stability of probiotics in drinking water, the suitability of probiotic dosage and probiotic storage factors (FAO., 2016).

CONCLUSION

Giving lactic acid bacteria (LAB) with a concentration of 10^8 CFU/ml to broiler chickens infected with *Escherichia coli*, research that has been carried out shows that this shows a better performance index. By adding lactic acid bacteria at a concentration of 10^8 CFU/ml on a farm scale of 2000 heads per period, the contribution margin can cover all fixed costs, so the road remains viable. The good performance index is due to the benefits of probiotics in improving gut health, increasing nutrient absorption and improving production performance such as body weight, feed conversion and lower chicken mortality.

Future research suggestions are the application of lactic acid bacteria (LAB) probiotics to chicken strains other than Cobb and carried out in different farm environments to identify chicken growth, intestinal health and broiler performance more fully. Comparing the effectiveness of probiotics from different lactic acid bacteria genus also needs to be done to determine the improvement of performance index.

NOVELTY STATEMENT

This review carried out in order to detect performance indices as well business analysis for broiler chickens infected with *Escherichia coli* via provides probiotic lactic acid bacteria (*Lactobacillus acidophilus*, *Lactobacillus casei* and *Lactobacillus plantarum*)

AUTHOR'S CONTRIBUTION

RA and DAC wrote the manuscript, WPL, SH and AM as research supervisors and editing the final version of the manuscript. All authors contributed to manuscript revisions, intellectual content, and approved the manuscript

for publication.

CONFLICT OF INTEREST

The authors have declared no conflict of interest with anyone

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