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# Evaluation of Differences Between Strains and Commercial Feed on Production Performance, Relative Weight of Immune Organs, Immune Profile, and Blood Profile of Broiler

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## Abstract:

To determine the effect of strain differences on broiler production performance (feed consumption, Feed Conversion Ratio (FCR), weight of immune organs (thymus and spleen), immune profile (CD4+ and CD8+), and blood profile (red blood cells) of broilers. This study used two broiler strains (Strain A1 and A2), with Day Old Chicks (DOC) and a total of 96 DOC in the strain. The maintenance period was 35 days. Treatment was given using three brands of commercial feed (PT. B1, PT. B2, and PT. B3). This study used a Completely Randomized Block Design (CRBD) with a 2x3 factorial pattern consisting of 6 treatments and 4 replications. The interaction of strain differences and different commercial feeds gave significantly different results (P>0.05) on feed consumption variables, and feed conversion (FCR). The interaction between strains and different commercial feeds gave very significant results (P>0.01) on CD 4+ and CD 8+ variables it can be concluded that different strain treatments have not been able to optimize all variables. This is because there are other factors that can affect variables such as the same environmental conditions in the maintenance phase, The treatment of giving different types of commercial feed gave significantly different results (P>0.05) on the variables of feed consumption and feed conversion (FCR), and The interaction between different strains and commercial feed gave results that had a very significant effect (P>0.01) on the CD 4+ and CD 8+ variables. The interaction between strains and feeds can increase cytotoxic T cells or cells that play a role in maintaining long-term protective immunity against bacterial infections.

*Keywords* — **Broiler, Strain, Commercial Feed, Blood Profile, and Immune Profile.**

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## I. INTRODUCTION

Broilers are a type of chicken that is cultivated for its meat. Broiler chickens are superior breeds of chickens that are crossbred from chicken breeds that have high productivity, especially in producing chicken meat. The development of broilers can currently be said to be experiencing very rapid development, this is proven by the increasing number of companies producing feed and companies producing strains.

The performance and growth of broiler strains can be influenced by several factors such as rearing management and the environment. Broiler growth is influenced by several maintenance management and environmental factors. The rearing management factor that has the greatest influence on broiler growth is feed. The feed usually given by broiler breeders is commercial feed which is a mixture of several ingredients arranged in a certain formulation where each feed supply company has a different ration formulation and source of ration constituent ingredients which is a secret from the company, so there may be differences in growth response (Pratiwi, et al. 2016)

Based on the description above, the differences in strains and differences in commercial feed used in this study are expected to provide information to the public, especially broiler farmers, about the results obtained from maintaining different broiler strains and also different commercial feeds on production performance (feed consumption and feed conversion (FCR)), relative weight of the thymus and spleen organs, blood profile (red blood cells), and CD4+ and CD8+ immune profiles.

## II. MATERIAL AND METHODS

### *A. Material*

This research used DOC (Day Old Chick) with a rearing period of 35 days from strains A1 and A2 with a total of 96 chickens from each strain so that the total number of unsexed chickens was 192 chickens. The average weight of the broiler DOC used was 38.36 ± 1.77 g and the coefficient of diversity was 4.35%. The weekly performance standards for broiler strains A1 and A2 used in this study can be seen in Table 1.

Table 1. Weekly Performance Standars for Strain A1 and A2

| Week | Body Weight (g/head) | Intake (g/head) | FCR |
|---|---|---|---|
| Strain A1 | | | |
| 1 | 187 | 165 | 0.885 |
| 2 | 477 | 532 | 1.115 |
| 3 | 926 | 1.176 | 1.270 |
| 4 | 1.498 | 2.120 | 1.415 |
| 5 | 2.140 | 3.339 | |
| Strain A2 | | | |
| 1 | 175 | 150 | 0.857 |
| 2 | 486 | 512 | 1.052 |
| 3 | 932 | 1.167 | 1.252 |
| 4 | 1.467 | 2.105 | 1.435 |
| 5 | 2.049 | 3.283 | 1.602 |

Source: PT Performance brochure A1 and A2

The feed used is commercial feed from animal feed companies PT. B1, PT. B2, PT. B3. The feed given is a starter type in the form of mash feed from DOC to harvest. Feed is given ad libitum in accordance with the consumption requirements table. Comparison of ingredient formulations and prices of 3 types of commercial feed brands can be seen in Table 2.

Table 2. Ingredient content of commercial feed

| Feed Brand | Feed Content | |
|---|---|---|
| | Feed Ingredients | Feed Additive |
| B1 | Corn, MBM, CGM, PALM OLEIN | Lysine, Methionine, Sodium Bicarbonate, Vitamins, Minerals |
| B2 | Soybean Meal, Fish Meal, Corn Gluten, Meat and Bone Meal, Oil, Corn | Calcium Phosphate, Vitamins, Minerals, Amino Acid, Phytase Enzyme |
| B3 | Corn, Soybean Meal, Groats, Rice Bran, DDGS, Corn Gluten, Meat and Bone Meal, Palm Oil, Palm Oil | Essential Amino Acids, Vitamins, Premise Minerals, Phytase Enzyme |

Source: PT Product label for each feed brand

  

### B. Methods

The research method used was experimental, designed using a Completely Randomized Block Design (CRBD) factorial pattern 2x3, with 6 treatments and 4 replications so that there were 24 treatment combination units, namely:

A1B1: Strain PT. A1 was treated with commercial feed produced by PT.B1

A1B2: Strain PT. A1 was treated with commercial feed produced by PT. B2

A1B3: Strain PT. A1 was treated with commercial feed produced by PT. B3

A2B1: Strain PT. A1 was treated with commercial feed produced by PT. B1

A2B2: Strain PT. A2 was treated with commercial feed produced by PT. B2

A2B3: Strain PT. A3 was treated with commercial feed produced by PT. B3

## III. RESULT AND DISCUSSION

The results of proximate analysis of the three brands of commercial feed used can be seen in Table 3:

Table 3. Nutrient content of commercial feed

| Content (%) | Commercial Feed | | |
|---|---|---|---|
| | B1 | B2 | B3 |
| Dry Ingredients (105 °C) | 90.30 | 90.42 | 89.03 |
| Ash | 6.77 | 5.27 | 6.60 |
| Proteins | 23.77 | 25.62 | 22.02 |
| Crude fat | 5.67 | 7.56 | 6.86 |
| Crude fiber | 1.42 | 1.87 | 2.26 |

Source: Results of Proximate Analysis of the Central Laboratory of Muhammadiyah University of Malang

A. ***The Effect of Different Strains and Commercial Feed Treatments on Broiler Production Performance***

Table 4. Average Effect of Interaction of Strains and Different Commercial Feeds on Broiler Production Performance

| Treatment | Feed Intake (gr) | FCR |
|---|---|---|
| A1 B1 | 3967 ± 5,07 | 2,1 ± 0,17 |
| A1 B2 | 4002 ± 38,63 | 1,9 ± 0,05 |
| A1 B3 | 4014 ± 44,16 | 1,9 ± 0,10 |
| A2 B1 | 3980 ± 33,01 | 2,0 ± 0,06 |
| A2 B2 | 3977 ± 1,05 | 1,9 ± 0,05 |
| A2 B3 | 4041 ± 75,16 | 1,9 ± 0,10 |

**The Effect of Interaction of Broiler Strains and Commercial Feed on Broiler Feed Consumption**

The effect of differences in commercial feed has a significant effect on broiler feed consumption ($P < 0.05$). This is because the three types of commercial feed used in this research (Feed B1, B2 and B3) have different feed and nutritional contents. It can be seen that commercial feed B3 provides a higher protein content compared to commercial feed B1 and B2. Considering that protein and energy content are the main components in feed. This is in line with the opinion of Wati, et al. (2018) that the main components of feed composition that are first considered are protein and energy content.

Based on observations and results of analysis of the variety of broiler feed consumption, the results of feed consumption were A1B1 (3967 ± 5.07 g/head), A1B2 (4002 ± 38.63 g/head), A1B3 (4014 ± 44.16 g/head), A2B1 (3980 ± 33.01 g/head), A2B2 (3977 ± 1.05 g/head), A2B3 (4041 ± 75.16 g/head).When viewed from these figures, there is a tendency for the provision of commercial feed B1, B2, and B3 to increase the level of broiler feed consumption during the study. This is because commercial feed types B1, B2, and B3 provide different levels of protein content, thereby providing different feed consumption as well. The average feed consumption in each treatment in this study showed that feed consumption in this study was relatively high from that recommended in the Charoen Pokphand (2016) guideline, which was 3283 g/head. The higher the protein content in the feed, the higher the feed consumption. This is in line with the opinion of Situmorang, et al (2013) that the amount of ration consumption reflects the amount of protein consumed. Feed consumption in broilers is influenced by the level of protein available in the feed consumed.

**The Effect of Interaction of Broiler Strains and Commercial Feed on Broiler Feed Conversion Ratio**

The effect of differences in commercial feed had a significant effect on broiler feed conversion during the study (P <0.05). Feed conversion or Feed Conversion Ratio (FCR) is greatly influenced by weight gain and feed consumption. This is supported by the statement of Maharatih, et al. (2017) explaining that feed conversion is influenced by feed consumption and weight gain. Ration conversion is defined as the amount of ration used to produce each kilogram of weight gain (Kartasudjana and Suprijatna, 2006).

Based on observations and results of the analysis of the variety of broiler feed conversion, the results were A1B1 (2.1 ± 0.17), A1B2 (1.9 ± 0.05), A1B3 (1.9 ± 0.10), A2B1 (2.0 ± 0.06), A2B2 (1.9 ± 0.05), A2B3 (1.9 ± 0.10). The feed conversion value in this study was higher than Safitri's opinion (2023) that the standard for broiler feed conversion for the Cobb strain during a 5-week maintenance period was 1.50. Maharatih, et al. (2017) added that each broiler rearing period has a different FCR value. The average FCR for broiler farms generally varies between 1.52 - 1.88. The high feed conversion value in this study is thought to be due to the many factors that affect the FCR value such as the type of feed used, environmental conditions, and maintenance methods applied during the study. According to Muharlien and Kurniawan (2010), the higher the feed conversion value, the more feed is needed to increase body weight per unit weight. Auza, et al. (2023) also added that the lower the FCR value, the better the broiler absorbs feed and converts it into meat. Feed conversion is useful for looking at the efficiency of feed use by livestock or the efficiency of using feed into the final product in broilers, namely the formation of meat. Low weight gain can be caused by pathogenic bacteria that develop in the digestive tract and interfere with nutrient absorption.

Table 5. Average Effect of Interaction of Strains and Different Commercial Feeds on Broiler Production Performance

| Treatment | Thymus (%) | Spleen (%) |
|---|---|---|
| A1 B1 | 0,40 ± 0,05 | 0,10 ± 0,04 |
| A1 B2 | 0,33 ± 0,03 | 0,11 ± 0,02 |
| A1 B3 | 0,32 ± 0,03 | 0,11 ± 0,03 |
| A2 B1 | 0,34 ± 0,07 | 0,12 ± 0,02 |
| A2 B2 | 0,30 ± 0,03 | 0,11 ± 0,01 |
| A2 B3 | 0,33 ± 0,03 | 0,10 ± 0,03 |

**The Effect of Interaction of Broiler Strains and Commercial Feed on the Percentage of Relative Weight of Broiler Thymus**

The difference in strain and commercial feed had no significant effect (P>0.05) on the relative weight of the broiler thymus organ. This is because the factors that affect the relative weight of the thymus organ are the number of immune cells, histological form, and age of the broiler (Putri et al., 2018). Apart from that, temperature and humidity can affect the relative weight of the thymus, and the relatively healthy physical condition of the chickens used as samples in the study. This is supported by the statement of Prasetyo, et al. (2018) who stated that the thymus is one of the broiler immune systems that can kill bacteria and viruses. The thymus has T cells whose role is to activate macrophages during phagocytosis, help B cells in antibodies, kill viruses and pathogenic bacteria.

Based on observations and results of analysis of the relative weight variance of broiler thymus organs in Table 5, the results were A1B1 (0.40 ± 0.05%), A1B2 (0.33 ± 0.03%), A1B3 (0.32 ± 0.03%), A2B1 (0.34 ± 0.07%), A2B2 (0.30 ± 0.03%), A2B3 (0.33 ± 0.03%). The average relative weight of the thymus organ in this study was higher than in the study by Leung et al. (2019), which ranges from 0.203 – 0.226%. The high relative weight of the thymus organ in this study could be because chickens that are kept at comfortable temperature conditions have a higher relative weight due to environmental conditions that support good chicken growth performance. The development of the relative weight of the thymus is in line with the development of T lymphocyte cells. According to Gao et al. (2017) who argue that the weight of the thymus is assumed to be the number of T lymphocyte cells.

**The Effect of Interaction of Broiler Strains and Commercial Feed on the Percentage of Relative Weight of Broiler Spleen**

The difference between strains and commercial feed had no significant effect (P>0.05) on the relative weight of the broiler bursa fabricius organ. This is because the content in the feed is relatively the same, so that the lymphoid organ responds equally to all feeds. Another factor that can influence the relative weight of the Bursa of Fabricius organ is the chicken's stress level regarding the environment. This is supported by a statement by Fajrih et al. (2014) stated that the relative weight of the bursa of Fabricius is influenced by the stress response to the environment.

Based on observations and analysis results of various relative weights of broiler bursa fabricius organs, the results were A1B1 (0.10 ± 0.08%), A1B2 (0.11 ± 0.04%), A1B3 (0.14 ± 0.03%) , A2B1 (0.13 ± 0.05 %), A2B2 (0.14 ± 0.04 %), A2B3 (0.15 ± 0.07 %). The relative weight of the bursa of Fabricius in the study was greater than the range of relative weights of the normal bursa of Fabricius according to Aprillia, et al (2018) that the normal relative weight of the bursa of Fabricius in broiler finishers is 0.07-0.11% (Aprillia et al., 2018). The greater the relative weight of the bursa fabricius, the more resistant it is to disease, because it contains normal immune follicles. According to Jamin (2012), bursa fabricius in young chickens develops rapidly and reaches its maximum size at the age of 4-12 weeks. Jamin (2012) stated that the bursa of Fabricius, which works hard to form antibodies for the body's resistance, will eventually experience depletion and shrinkage of the lymphoid follicles so that their relative weight decreases.

Table 6. Average Effect of Interaction of Strains and Different Commercial Feeds on Broiler Production Performance

| Treatment | CD 8+ | CD 4+ |
|---|---|---|
| A1 B1 | 23,38 ± 6,93 | 0,49 ± 0,22 |
| A1 B2 | 42,66 ± 3,14 | 0,10 ± 0,05 |
| A1 B3 | 26,04 ± 8,25 | 0,44 ± 0,16 |
| A2 B1 | 26,55 ± 11,28 | 0,55 ± 0,14 |
| A2 B2 | 20,89 ± 4,43 | 0,75 ± 0,15 |
| A2 B3 | 28,68 ± 1,56 | 0,22 ± 0,08 |

**The Effect of Strain Differences and Commercial Feed on the Percentage of Broiler CD4+ and CD8+ Cells**

Based on Table 6. The relative cell count of CD8+ is higher than the number of CD4+. Based on Table 6, differences in strains and commercial feed have a very significant influence (P<0.01) on broiler CD8 cells. This is supported by the statement from Pinca, et al (2013) that the results of the relative number of CD4+ and CD8+ cells using Flowcytometry analysis did not show any significant differences between each treatment in the thymus resulting from starter phase surgery. The treatment of factory feed (A1B1) and factory feed + S. typhimurium infection (A2B1) showed a relative number of CD8+ cells that was higher than the number of CD4+, namely 0.31% and 0.5%.

Based on the observation and results of the analysis of the variety of broiler CD8+ cells, the results were A1B1 (23.38±6.93%), A1B2 (42.66±3.14%), A1B3 (26.04±8.25%), A2B1 (26.55±11.58%), A2B2 (20.89±4.43%), A2B3 (28.68±1.56%). The CD8+ cells in this study were greater than the average results from the research of Febrianti and Djati (2015). The analysis of the relative number of CD4+ and CD8+ T cells in this study aimed to determine the effect of giving papaya leaf flour in the ration on modulating the number of CD4+ T cells and CD8+ in the spleen organ of white Arab chickens. The average result of the CD8+ T lymphocyte cell count in the control treatment was 9.14%.

The highest relative percentage of CD8+ broiler cells in this study belonged to the A1B2 treatment with a value of 42.66%, followed by the

  

A2B3, A2B1, A1B3, A1B1 treatments, and the lowest was A2B2 with a value of 20.89%. The relative number of CD8+ cells in this study was greater than the results of Pradana's (2013) study on CD8+ cells, the highest relative number was in the A4B2 treatment with an average value of 29.30%, then followed by the A3B2, A5B2, A2B2 treatments, and the lowest was A1B2 with a value of 15.47%.

The average percentage of CD8+ cells in this study was greater when compared to the percentage of CD4+ cells in this study. This is due to the function of CD8+ cells as cytotoxic which can kill types of viruses in the broiler's body. This is supported by the statement of Abbas (2000) that activated CD8+ lymphocyte cells will proliferate and differentiate into cytotoxic T cells (CTL) which can kill cells in whose cytoplasm microbes are hidden. These microbes can be viruses that infect many types of cells or bacteria that have been digested by macrophages but have a way to escape from phagocytic vesicles and move to the cytoplasm. By destroying infected cells, CTLs can eliminate primary sites of infection.

Table 7. Average Effect of Interaction of Strains and Different Commercial Feeds on the Appearance of Broiler Blood Profiles

| Treatment | Red Blood Cell | White Blood Cell |
|---|---|---|
| A1 B1 | 2,58 ± 0,31 | 20,41 ± 0,75 |
| A1 B2 | 2,82 ± 0,14 | 20,65 ± 0,05 |
| A1 B3 | 2,79 ± 0,23 | 20,54 ± 0,83 |
| A2 B1 | 2,95 ± 0,57 | 20,55 ± 0,93 |
| A2 B2 | 2,60 ± 0,31 | 20,50 ± 0,88 |
| A2 B3 | 2,53 ± 0,28 | 20,72 ± 1,88 |

**The Effect of Strain Differences and Commercial Feed on Broiler Red Blood Cells**

Based on Table 7, the difference between strains and commercial feed had no significant effect (P>0.05) on broiler red blood cells. Several factors that affect broiler red blood cells are strain, age, rearing system, and rearing environmental temperature. This is supported by a statement by Alfian, et al. (2017), namely age, sex, breed or strain of chicken, production period, altitude, movement activities, rearing system, and environmental temperature can influence the red blood cell content of broiler chickens. The nutritional content of feed can also affect the process of erythrocyte formation, as explained by Hanifa, et al. (2017) that in the process of forming new red blood cells every day, precursors are needed to synthesize new cells. These precursors include iron, vitamins (especially vitamin B), and amino acids. Red blood cells generally function in gas exchange and oxygen distribution in cells to smooth metabolic processes (Yuniwarti, 2015).

Based on observations and results of analysis of broiler red blood cell variance, the results were A1B1 (2.58 ± 0.31 ×106 /mm$^3$), A1B2 (2.82 ± 0.14 ×106 /mm$^3$), A1B3 (2.79 ± 0.23 ×106 /mm$^3$), A2B1 (2.95 ± 0.57 ×106 /mm$^3$), A2B2 (2.60 ± 0.31 ×106 /mm$^3$), A2B3 (2.53 ± 0.28 ×106 /mm$^3$). The red blood cells in this study were still within the normal range. This is supported by Samour's statement (2015) which states that the normal range of chicken erythrocyte count is between 2.5-3.9 ×106/mm3.

**The Effect of Strain Differences and Commercial Feed on Broiler White Blood Cells**

Based on Table 7, the difference between strains and commercial feed had no significant effect (P>0.05) on broiler white blood cells. The number of white blood cells in the blood can be influenced by several factors such as disease, age, sex, hormones, livestock activity, feed, stress experienced by livestock, and environmental conditions during the study. This is comparable to the statement by Nasrullah, et al., (2020) that the number of leukocytes in the blood is influenced by several factors including the presence of disease agents, age, sex, hormones, livestock activity, feed, stress experienced by livestock, and environmental conditions.

Based on observations and results of analysis of the variety of broiler white blood cells, the results were A1B1 (20.41 ± 0.75 × 103 / mm$^3$), A1B2 (20.65 ± 0.05 × 103 / mm$^3$), A1B3 (20.54 ± 0.83 × 103 / mm$^3$), A2B1 (20.55 ± 0.93 × 103 / mm$^3$), A2B2 (20.50 ± 0.88 × 103 / mm$^3$), A2B3 (20.72 ± 1.88 × 103 / mm$^3$). White blood cells in this study were still within the normal range. This is comparable to the statement by Arfah (2015) that the number of normal leukocytes in broilers is in the range of 12 - 30 ×103/mm$^3$. According to Wulandari, et al. (2014) the higher the white blood cell count, the better because it indicates an increase in the immune system, meaning the livestock is in good health. The process of forming leukocytes requires protein intake in the form of amino acids, so the protein content in feed must be sufficient. Changes in the number of white blood cells that are too far from the normal number (lower/higher) indicate an attack by a disease agent in the form of inflammation, autoimmune, and/or allergic reactions (Lestari, et al., 2013).

## IV. CONCLUSION

1) Different strain treatments have not been able to optimize all variables. This is because there are other factors that can affect variables such as the same environmental conditions in the maintenance phase.

2) The treatment of giving different types of commercial feed gave significantly different results (P>0.05) on the variables of feed consumption and feed conversion (FCR)

3) The interaction between different strains and commercial feed gave results that had a very significant effect (P>0.01) on the CD 4+ and CD 8+ variables. The interaction between strains and feeds can increase cytotoxic T cells or cells that play a role in maintaining long-term protective immunity against bacterial infections

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