

## Evaluation of The Effect of Replacing Commercial Concentrate with Broiler Farm Waste Concentrate on Production Performance and Physical Quality of Bali Duck Meat

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### ABSTRACT

This study aims to evaluate the effect of partially substituting commercial concentrate (CC) with concentrate based on broiler chicken farm waste (CBB) on the production performance and physical quality of bali duck meat. The study used a completely randomised design (CRD) with three treatments and five replicates (10). The treatments consisted of rations with 25% CC+0% CBB (T0), 12.5% CC+12.5% CBB (T1), and 0% CC+25% CBB (T2). The parameters observed included performance (weight gain, feed intake, feed conversion ratio) and physical quality of the meat (pH, water-holding capacity, cooking loss, and meat colour). The results showed that the use of CBB up to 25% (T2) had no significant effect ( $P>0.05$ ) on the production performance of bali ducks (feed consumption, weight gain, FCR), or was the same as the control ( $P>0.05$ ). Replacing CC with 12.5% and 25% CBB reduced the physical quality of the meat ( $P<0.05$ ), but did not affect the colour of the bali duck meat ( $P>0.05$ ). It is concluded that replacing CC with 12.5%-25% CBB can sustain the performance and colour of bali duck meat, but can reduce the physical quality of bali duck meat.

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**KEYWORDS:** Bali ducks, broiler waste concentrate, performance, meat quality, feed efficiency

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### INTRODUCTION

The Bali duck is one of Indonesia's local poultry breeds with great potential for meat and egg production (Endoh et al., 2016). The main advantages of Bali ducks are their high adaptability to tropical environments and resistance to disease. However, the development of Bali duck farming still faces various obstacles, especially in terms of feed, which accounts for 60–70% of total production costs (Ardani et al., 2025; David et al., 2025). The use of commercial concentrates, which are relatively expensive, is often a limiting factor in improving the efficiency of smallholder farming (Karang, 2017).

On the other hand, the broiler chicken farming sector produces large amounts of waste, including feed residues mixed with litter, dry manure, and other organic waste from closed house systems (Guntoro, 2018; Oka et al., 2023). This waste has the potential to be utilised as an alternative raw material in the manufacture of concentrates because it still contains important nutrients such as protein, fat, and minerals (Ariana et al., 2022; Oka et al., 2023). Processing broiler waste into waste-based concentrate (through fermentation or controlled drying) can increase the availability of cheap feed, reduce environmental pollution, and support the concept of zero waste in sustainable livestock systems (Ariana et al., 2023b).

Previous studies have reported that the use of broiler chicken manure as feed can reduce production costs without reducing the performance of Landrace and Bali pigs when given at the right level (Ariana et al., 2022; Partama et al., 20). Broiler chicken litter meal has a crude protein content of approximately 22.42%, while dead or culled broiler chicken meal contains approximately 56.97% crude protein (Ariana, 2023; Ariana et al., 2023b). However, information on the use of broiler farm waste-based concentrates in Bali ducks is still limited, particularly regarding their impact on production performance and meat quality. Therefore, this study was conducted to examine the extent to which partial substitution of commercial

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concentrates with broiler farm waste-based concentrates affects the production performance and meat quality of Bali ducks.

## MATERIALS AND METHODS

### Bali Duck

This study used Bali ducks (*Anas Sp*) as the research subjects. The Bali ducks used in this study were 150 male Bali ducks aged 1 week with an average weight of  $172.83 \pm 13.32$  g, which were then grouped according to the treatment to be given.

### Broiler Chicken Farm Waste Protein Concentrate (CBB)

Broiler chicken farm waste protein concentrate (CBB) is made by collecting litter containing broiler feed residue that has fallen around the feeding area, then drying the litter in the sun until it is dry, after which the litter is ground into flour. The flour is then fermented for 3 days. Discarded broilers and broiler carcasses are cut into pieces and then oven-dried at 80-100°C for 2 hours. After finishing the oven-drying process, it is ground into meat flour, then mixed in a ratio of 66.3% (litter flour) : 33.7% (meat flour) (Oka et al., 2023).

### Research Design

The design used in this study was a completely randomised design (CRD) with 3 treatments and 5 replicates. There were 15 experimental cages, each cage containing 10 bali ducks. Thus, the study used 150 one-week-old bali ducks with an average body weight of  $172.83 \pm 13.32$  g. The treatments were as follows:

T0: Rations with 25% commercial concentrate (CC) + 0% CBB (control).

T1: Rations with 12.5% CC + 12.5% CBB. T2: Rations with 0% CC + 25% CBB.

The composition of the bali duck rations (research) is as shown in Table 1, and the nutritional content of each treatment is as shown in Table 2.

### Research Variables

The research variables were: Performance (initial weight, feed intake, final weight, weight gain, FCR), physical quality of meat: pH (measured 24 hours postmortem using a pH meter), cooking loss, water holding capacity, and meat colour (using the CIE L\*, a\*, b\* colour system).

### Statistical analysis

The observation data were analysed using analysis of variance (ANOVA) according to a completely randomised design. If there was a significant effect between treatments ( $P < 0.05$ ), it was followed by a Significant Difference Test (SDT) at a 5% significance level to determine the differences between treatments (Steel and Torrie, 2017).

## RESULTS AND DISCUSSION

### Performance Feed consumption

The results of the evaluation of the effect of replacing commercial concentrate (CC) with Broiler Chicken Farm Waste Protein Concentrate (CBB) on the performance of bali ducks (*Anas Sp.*) can be seen in Table 3. The feed consumption of bali ducks in the control group (T0) was 4273.67 g/bird. Bali ducks in the T2 treatment group produced the highest feed consumption ( $P > 0.05$ ). This was due to the replacement of commercial concentrate with Poultry Farm Waste Protein Concentrate, which increased palatability as a result of the fermentation process in litter waste and spent chickens (Ariana et al., 2023c). This is in line with the statement by Nadhifah et al (2012) that fermented feed ingredients produce good physical quality and high palatability compared to non-fermented ones. Furthermore, Zumiarti et al. (2017) stated that consumption is influenced by nutritional content; the lower the energy and protein provided, the higher the feed intake because livestock will continue to eat until their energy needs are met, and vice versa.

### Body Weight Gain

The weight gain of Bali ducks showed an increasing trend over time. The average weight gain in group T2 was highest compared to T0 and T1 ( $P > 0.05$ ), as a result of the highest feed consumption in treatment T2, which also resulted in high weight gain. This is in line with Abun's (2015) research, where increased feed consumption had a significant effect on weight gain. High food intake can result in weight gain, while low food intake can result in underweight. Each livestock has a different growth capacity, and feed consumption is key for livestock to achieve optimal performance, where livestock kept in different numbers also require different feed portions (Tantalo, 2009). Environmental factors such as humidity and temperature during the livestock rearing period also have a significant impact on duck weight. Ducks will achieve maximum productivity in a comfortable environment (Karang, 2017).

### **Final Body Weight**

The final weight of bali ducks in group T0 obtained the highest final weight (1400.83 g) compared to the final weight of bali ducks given other treatments ( $P>0.05$ ). This was due to the fact that in the T0 treatment, the composition of the commercial feed (Table 1.) and nutritional content (Table 2.) consisted of complete protein (quantity and quality) when compared to the T1 and T2 groups. Metabolic results were supported by the quality and quantity of feed consumed and the optimisation of feed utilisation. Poultry require adequate nutritional intake to increase their body weight during the growth period. One way to achieve this is by increasing feed consumption (Mykola et al., 2021). The quality of the feed provided will affect livestock growth and protein utilisation efficiency. In this study, the highest protein level in the T0 treatment ( $P>0.05$ ) could increase body weight growth and final weight of bali ducks. Final body weight is influenced by the amount of feed consumed and the nutritional content of the feed. Fulfilling the nutritional needs of bali ducks ensures they achieve optimal final weight (Ariana et al., 2022).

### **Feed conversion Ratio**

Feed conversion ratio (FCR) is the ratio between feed consumption and weight gain. The average FCR for Bali ducks in the T0 group was 3.34 (Table 3). The results of this study showed that the FCR values for treatments T2 and T2 were 3.35 and 3.37, however, these were not statistically significant ( $P>0.05$ ). This was due to the direct effect of feed consumption and additional weight gain. The nutritional content in each treatment (Table 2) was almost the same, and the livestock's ability to digest feed was relatively the same, causing the FCR between treatments to be not significantly different ( $P>0.05$ ). Another factor was high feed consumption, which increased the feed conversion ratio. FCR is a measure of the efficiency of livestock in utilising the feed provided to convert it into body weight. The magnitude of the FCR value is influenced by the digestibility of ducks, the quality of feed consumed, and the compatibility of the nutritional content in the feed (Fanani et al., 2014). The FCR value is closely related to feed utilisation efficiency during growth and is defined as the ratio of feed intake to weight gain. A low feed conversion ratio indicates that livestock can digest and absorb feed into meat (Ariana et al., 2023a).

### **Physical Quality of Meat pH**

The results of the analysis (Table 4) show that the pH value of bali duck meat given broiler chicken waste protein concentrate (CBB) obtained values between T0 (6.17) lower than T1 (6.22) and T2 (6.30) ( $P<0.05$ ). This difference was due to the effect of the amount of commercial concentrate (Table 1) and the crude protein content in the T0 group (Table 2), which was higher than in the T1 and T2 groups. Good nutritional content, especially a high energy and protein balance, will have a positive effect on meat pH (Ariana et al., 2023a). Ante- mortem muscle glycogen reserves can also affect initial pH and ultimate pH (Soeparno, 2015; Mykola et al., 2021). The TDN content in treatment T0 (84.32%) was higher than in T1 (71.61%) and T2 (67.76%) (Table 2). This difference indicates that CBB is not yet able to optimally meet the protein requirements of livestock, especially to maintain the pH value of bali duck meat. The pH value of meat is a major factor affecting the quality and shelf life of meat as a feed ingredient. In this study, the ultimate pH of meat was determined by the accumulation of lactic acid in the muscles after slaughter. The accumulation of lactic acid and the achievement of ultimate pH depend on the amount of muscle glycogen at the time of slaughter (Lawrie, 2003). The normal ultimate pH of meat after slaughter is in the range of 5.4- 5.8, which corresponds to the isoelectric point of most meat proteins, including myofibril proteins (Soeparno 2015). The initial pH value of the duck meat in this study was still within the normal range: 6.0 – 6.5 (SNI 7388, 2009).

### **Water Holding Capacity (WHC) and Cooking Loss (CL)**

Water Holding Capacity (WHC) is the ability of meat to stores water, both naturally present and added, while cooking loss (CL) is the amount of weight loss during the cooking/boiling process. WHC values are always inversely proportional to CL values (Soeparno, 2015). The WHC value at T0 (33.40%) was significantly higher than at T1 (31.00%) and T2 (30.00%) ( $P,0.05$ ). The CL value at T0 (40.00%) was significantly lower than at T1 (41.80%) and T2 (42.00%) ( $P < 0.05$ ) (Table 4). The crude protein content in treatment C (17.41%) was lower than that in the control diet, but the crude fibre content (5.97%) and crude fat content (5.97%)

(Table 2) were higher than those in the control diet. These conditions can significantly affect the decline in meat quality, particularly in terms of pHu, WHC, DL, and CL parameters. Diets with relatively low nutrient content and high crude fibre and crude fat content tend to reduce meat water-holding capacity (WHC) and increase cooking loss (CL) and drip loss (DL) (Lawrie, 2003; Ariana et al., 2023a). Cooking loss (CL) is directly proportional to drip loss (DL), but inversely proportional to water holding capacity (WHC). High WHC in meat will reduce CL and DL values (Lawrie, 2003; Soeparno 2015). The physical quality of meat in this study is consistent with this opinion, because the ration content in treatments T1 and T2 (Table 1), which used 12.5% and 0% commercial concentrate, can reduce the nutritional content of the ration.

### **Colour**

The colour of meat is one of the main factors in determining its physical quality and is an indicator of its freshness. This factor plays an important role in three aspects, namely attractiveness, identification, and quality parameters (SNI, 2006). Colour testing is conducted objectively using a Hunter Lab Colorimeter, Poultry Meat Colour Standard (CIE  $L^*a^*b^*$ ), which measures colour based on three main parameters, namely  $L^*$ ,  $a^*$ , and  $b^*$ . The  $L^*$  value indicates the level of brightness on a scale of 0-100, where a higher value indicates a brighter colour. The results showed that the  $L^*$  value of T0 (40.55),  $a^*$  (12.80),  $b^*$  (4.50), based on the poultry meat colour standard (duck) (CIE  $L^*a^*b^*$ ) assessment, was statistically the same as the duck meat colour values in groups T1 and T2 ( $P>0.05$ ) (Table 4). This condition was due to the fact that the nutritional content effects between treatments (T0, T1, T2) in Table 2 were almost the same. Pre-slaughter treatments, including the nutritional content of the feed, greatly influence meat colour (Lawrie, 2003; Soeparno 2015).

The value of  $a^*$  ranges from negative (green) to positive (red). The red colour of duck meat is caused by the pigment myoglobin, a complex protein that carries oxygen to muscle cells. Fresh meat from newly slaughtered animals is purple-red due to the pigment myoglobin. If left alone, myoglobin will react with oxygen and turn into bright red oxymyoglobin. If left again, oxyhaemoglobin will react with oxygen and turn into methaemoglobin, which is brown in colour. The colour of meat is influenced by several factors, such as feed, species, age, sex, stress, pH, and oxygen (Lawrie, 2003). Red meat is meat that is high in haemoglobin content, such as beef, lamb, goat, or pork. White meat contains low levels of myoglobin, such as chicken, duck, and turkey. Duck meat has a higher iron content than poultry such as chicken and turkey (Soeparno, 2015).

The  $b^*$  value ranges from negative (blue) to positive (yellow). One factor that causes a significant increase in yellowness ( $b^*$ ) is the presence of beta-carotene. It is suspected that beta-carotene found in corn bran and broiler feed residues scattered in the litter (KLB) in certain treatments contributes to the change in meat colour to a more yellowish colour, resulting in a noticeable difference in  $b^*$  values. Meat colour is also influenced by several other factors, such as breed, sex, age, species, oxygen content, stress level (physical activity and type of o tot), and pH value (Hughes et al., 2014). From the data in this study, the meat colour value of ducks in the breast area based on the CIE  $L^*a^*b^*$  assessment can be said to fall within the general characteristics of duck meat: dark reddish colour with a harder texture (SNI, 2006; Anik et al., 2022).

### **CONCLUSION AND RECOMMENDATIONS**

Replacing commercial concentrate with Broiler Chicken Farm Waste Concentrate (CBB) can sustain the performance of Bali ducks (final weight, weight gain, and feed intake). Replacing 12.5% and 25% of CBB can reduce the physical quality of duck meat in terms of pH, WHC, and CL, but does not cause any changes in meat colour, which remains the same as that of the control group. Based on the results of this study, it can be recommended to farmers that, in order to maintain the performance and colour of Bali duck meat, commercial concentrate should be replaced with 25% Poultry Broiler Waste Protein Concentrate (CBB) (of the total ration).

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### **CONFLICT OF INTEREST**

The authors certify that there is no conflict of interest with any financial, personal, or other relationships with other people or organization related to the material discussed in the manuscript.

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**Table 1. Composition of Bali duck rations (research)**

| Material              | Treatment (%) |      |     |
|-----------------------|---------------|------|-----|
|                       | T0 (Control)  | T1   | T2  |
| Concentrate Comersial | 25            | 12.5 | 0   |
| KLB                   | 0             | 12.5 | 25  |
| Pollard               | 35            | 35   | 35  |
| Corn                  | 39            | 39   | 39  |
| Mineral mix           | 1             | 1    | 1   |
| Total                 | 100           | 100  | 100 |

Keterangan: T0 : Ration with 25% CC + 0% KLB (control) T1 : Ration with 12.5% CC + 12.5% KLB

T2 : Ration with 0% CC + 25% KLB

**Table 2. Nutritional content of treatment rations**

| No. | Nutrient      | Units    | Treatment |       |       | Standard*) |
|-----|---------------|----------|-----------|-------|-------|------------|
|     |               |          | T0        | T1    | T2    |            |
| 1   | Dry mater     | %        | 86.71     | 87.73 | 85.59 | -          |
| 2   | Water content | %        | 13.29     | 12.27 | 14.41 | Max.14,00  |
| 3   | Ash           | %        | 6.31      | 7.12  | 7.31  | Max.8,00   |
| 4   | Crude protein | %        | 18.86     | 17.78 | 17.41 | Min.15,00  |
| 5   | Crude fiber   | %        | 6.01      | 6.87  | 6.65  | Max.7,00   |
| 6   | Crude fat     | %        | 4.61      | 5.52  | 5.97  | Max.7,00   |
| 7   | TDN           | %        | 84.32     | 71.61 | 67.76 | -          |
| 8   | Energi (ME)   | K.cal/kg | 3027      | 3149  | 3126  | Min. 2900  |

\*) SNI., 2006

**Table 3. Effect of Broiler Chicken Waste Protein Concentrate on the performance of bali ducks (*Anas sp.*)**

| Variabel                     | Treatment <sup>1)</sup> |                      |                      | SEM <sup>2)</sup> |
|------------------------------|-------------------------|----------------------|----------------------|-------------------|
|                              | T0                      | T1                   | T2                   |                   |
| Initial Body Weight (g/ekor) | 172.33 <sup>a</sup>     | 172.63 <sup>a</sup>  | 172.87 <sup>a</sup>  | 1,4               |
| Feed Comsumsion (g/ekor)     | 4273.67 <sup>a</sup>    | 4291.67 <sup>a</sup> | 4264.50 <sup>a</sup> | 13,17             |
| Wight Gain (g/ekor)          | 1279.50 <sup>a</sup>    | 1282.20 <sup>a</sup> | 1264.54 <sup>a</sup> | 11,46             |
| Final Body Weight (g/ekor)   | 1400.83 <sup>a</sup>    | 1394.53 <sup>a</sup> | 1379.87 <sup>a</sup> | 11,35             |
| Feed Conversion Ratio        | 3.34 <sup>a</sup>       | 3.35 <sup>a</sup>    | 3.37 <sup>a</sup>    | 0,20              |

Keterangan :

1) T0 : Ration with 25% CC + 0% KLB (kontrol)

2) T1 : Ration with 12.5% CC + 12.5% KLB

T2 : Ration with 0% CC + 25% KLB

3) SEM : *Standard Error of the Treatment Means*

4) Values with different superscripts in the same row indicate a significant difference (P<0.05)

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**Table 4. Physical Quality of Meat from Bali Ducks Feeding Concentrated Protein from Broiler Chicken Farm Waste.**

| Treatment | Variable            | T0                 | T1                 | T2                 | SEM  | Standard*) |
|-----------|---------------------|--------------------|--------------------|--------------------|------|------------|
| pH        |                     | 6.17 <sup>b</sup>  | 6.22 <sup>a</sup>  | 6.30 <sup>a</sup>  | 0.05 | 6.0-6.5    |
|           | WHC (%)             | 33.40 <sup>a</sup> | 31.00 <sup>b</sup> | 30.00 <sup>b</sup> | 0.04 | 20 - 60    |
|           | CL (%)              | 40.00 <sup>b</sup> | 41.80 <sup>a</sup> | 42.00 <sup>a</sup> | 0.10 | 1.5 - 54   |
|           | Colour (CIE L*a*b*) |                    |                    |                    |      |            |
| L*        |                     | 40.55 <sup>a</sup> | 44.75 <sup>a</sup> | 43.45 <sup>a</sup> | 1.41 | 0 - 100    |
| a*        |                     | 12.80 <sup>a</sup> | 11.70 <sup>a</sup> | 10.90 <sup>a</sup> | 1.13 | 0 - 80     |
| b*        |                     | 4.50 <sup>a</sup>  | 5.10 <sup>a</sup>  | 5.00 <sup>a</sup>  | 1.05 | 0 - 70     |

Note: T0 : Ration with 25% CC + 0% KLB (kontrol) T1 : Ration with 12.5% CC + 12.5% KLB

T2 : Ration with 0% CC + 25% KLB

SEM= "Standard Error of the Treatment Means".\*) Soeparno (2015), SNI 7388 (2009). Values with different superscripts in the same row indicate a significant difference (P<0.05)L\*(brightness), a\*(greenish red), b\*(yellowish blue).