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Optimizing growth: A starter ration study for *IPB D-1* chicks

Sekar Ayu Hawatama Ramadhani[1], *Muhammad* Ridla[2,3*], and *Arif* Darmawan[2]

[1]Graduate Student of Animal Nutrition and Feed Science, IPB University, Indonesia
[2]Department of Animal Nutrition and Feed Technology, IPB University, Indonesia
[3]Center for Tropical Animal Studies (CENTRAS), IPB University, Indonesia

Abstract. Poultry nutrient requirements are significantly influenced by both growth stage and breed. Additionally, housing systems impact performance. However, specific starter ration guidelines and appropriate housing systems are lacking for the IPB D-1 chicken, a hybrid combining 75% local and 25% broiler genetics. This critical period demands protein-rich diets to achieve optimal growth. To address this gap, a study was conducted to investigate the impact of varying protein levels (22% and 20%) in starter rations for unsexed, day-old IPB D-1 chicks (n = 400). The chicks were divided into two dietary groups and housed in open and semi-closed housing systems (10 replicates of 10 chicks each). Feed and water were provided ad libitum for 2 weeks, and monitoring of feed intake, weight gain, and feed conversion ratio (FCR) was performed. Chicks fed the 22% protein diet displayed significantly higher ($P<0.05$) feed intake and weight gain compared to the 20% group. Additionally, a noticeably improved FCR was observed. Housing type significantly affects ($P<0.05$) these measured parameters, with the semi-closed housing system being superior. This study highlights the enhanced response of IPB D-1 chicks during the starter phase to a higher protein content ration and a semi-closed housing system.

1 Introduction

Poultry's nutrient requirement depends heavily on the growth stage and breed. The starter phase is a critical period that demands protein-rich diets for optimal growth [1]. Conditions during the starter period will affect the development of chickens during the grower and finisher periods [2, 3]. Chicken growth performance in the starter will influence chicken performance throughout all growth phases. In the early stages after hatching, the development of the digestive tract and its absorption capacity are still not optimal [4]. Therefore, the ration given must have the right nutritional quality to support the early growth of chickens.

The success of a farm can also be influenced by the choice of cage type. The open house system relies on natural ventilation with open sides, making it dependent on the external climate. It has a simple construction with wire mesh or netting walls, resulting in lower costs. Natural daylight is used with minimal supplemental lighting. This system has limited control over humidity, temperature, and air quality, exposing broilers to weather conditions. Its main

* Corresponding author: hmridla@apps.ipb.ac.id

advantages are cost-effectiveness and simplicity, but it faces environmental variability and higher biosecurity risks, affecting broiler health and performance [5]. The semi-close house system uses controlled ventilation with exhaust fans, providing better temperature regulation. It has enclosed walls with adjustable openings, leading to higher costs. Artificial lighting regulates day length and intensity. This system offers improved control over environmental conditions, enhancing broiler performance and biosecurity, but requires greater investment and technical knowledge [5, 6]. Based on research by Nuryati [7], keeping broiler chickens in closed-housed and open-housed affects feed consumption, body weight, and FCR. Raising broiler chickens in closed houses results in a higher final body weight.

The IPB D1 chicken was developed to address a key challenge of indigenous breeds: slow growth rate. These breeds are prized for their flavor, disease resistance, and ability to utilize local feed. IPB D1 incorporates rapid-growth genes from broiler chickens (25% of its genetic makeup) through a crossbreeding initiative with three local chicken lineages (Kampung, Pelung, and Sentul) – each contributing 25% [8].

Previous studies have reported that IPB D1 chickens have achieved accelerated growth, reaching a slaughter weight of 1.18-1.36 kg when fed high levels of protein and metabolizable energy (21%, 2950 kcal/kg), and of 0.967-1.17 kg when fed low-level protein and metabolizable energy (17%, 2689 kcal/kg) at 12 weeks of age [8]. This achievement (1.18-1.36 kg, when fed high levels of protein and metabolizable energy) surpasses the weights of local chickens (1.04-1.07 kg) as reported by Nurhayu et al. [9]. Additionally, IPB D1 chickens demonstrate the ability to assimilate local feed ingredients as their primary source of nutrition while simultaneously maintaining the health aspects of livestock.

However, there is still a lack of data on IPB D1 chickens as a new breed regarding their nutrient requirements and performance during the starter period, including protein levels in the ration, and housing conditions capable of supporting optimum growth conditions. It is important to gather information regarding the impact of variations in protein levels and the type of cage system during the starter period of IPB D1 chickens. This information serves as a guideline for subsequent maintenance of IPB D1 chickens with optimal levels of productivity.

2 Materials and methods

The study investigated the effect of protein content and housing type on the growth of IPB D1 chicks. A total of 400 unsexed chicks (1-14 days old) were divided into four groups with 10 replications each (10 chicks per replication). These groups were fed either a low-protein or high-protein diet and were housed in open or semi-closed systems. The detailed treatments were: low protein with open housing (P0H0), high protein with open housing (P1H0), low protein with semi-closed housing (P0H1), and high protein with semi-closed housing (P1H1). Chicks had unlimited access to feed and water for 2 weeks. Feed consumption is measured by calculating the difference between feeding and residual feed. Measuring residual feed is carried out every morning before giving new feed. The parameters monitored were: feed intake, weight gain, and feed conversion efficiency (FCR).

To assess the effectiveness of the four diets and housing combinations, a statistical Completely Randomized Design (CRD) was employed. Data were then analyzed using statistical analysis software (SPSS Statistics for Windows, Version 25.0). If significant differences were found between groups, a further test, specifically Tukey's post-hoc test, was utilized [10].

The ingredient content and nutritional composition of the utilized starter ration in the study are detailed in Table 1.

Table 1. Ingredient content and nutritional composition of utilized starter ration

Ingredient (%)	Low protein	High protein
Yellow corn	60.00	59.00
Rice bran	7.55	6.55
Corn gluten meal	14.50	16.50
Soybean meal	6.00	6.00
Meat and bone meal	6.50	6.50
Crude palm oil	3.00	3.00
CaCO3	0.80	0.80
NaCl	0.20	0.20
Premix	0.50	0.50
DL-Methionine	0.40	0.40
Lysin	0.45	0.45
Tryptophan	0.10	0.10
Total	100	100
Nutrient content		
Dry matter, %	89.77	89.77
ME (kcal kg^{-1})	3004.95	3004.95
Crude protein, %	20.05	22.12
Ether extract, %	6.56	6.56
Crude fiber, %	5.36	5.36
Lysine, %	1.16	1.16
Methionine, %	0.68	0.68
Ca, %	0.95	0.95
P avail., %	0.49	0.49
Na, %	0.16	0.16
Cl, %	0.20	0.20

3 Results

The research results of the performance of IPB D1 chicken reared at 1-7 days and 8-14 days are presented in Tables 2 and 3. In addition, the temperature and relative humidity recorded during the 14-day rearing period are shown in Figures 1 and 2.

Table 2. Chicken performance at 1-7 days period

Variables	P0H0	P1H0	P0H1	P1H1
Feed intake ($g\ chick^{-1}day^{-1}$)	13.20 ± 0.98^{a}	13.58 ± 0.74^{a}	11.75 ± 0.38^{a}	12.98 ± 0.31^{a}
Total feed intake ($g\ chick^{-1}$)	92.43 ± 6.88^{a}	95.07 ± 5.22^{a}	82.23 ± 2.68^{b}	90.89 ± 2.10^{b}
Body weight gain ($g\ chick^{-1}day^{-1}$)	5.65 ± 0.43^{b}	6.98 ± 0.78^{b}	6.65 ± 3.04^{b}	7.25 ± 0.43^{b}
Total body weight gain ($g\ chick^{-1}$)	39.70 ± 3.04^{b}	48.87 ± 5.44^{a}	46.57 ± 3.44^{a}	50.78 ± 5.05^{a}
FCR	2.33 ± 0.2^{a}	1.96 ± 0.24^{b}	1.77 ± 0.09^{bc}	1.63 ± 0.21^{c}
Mortality (%)	0	0	0	0

P0H0: low protein with open housing; P1H0: high protein with open housing; P0H1: low protein with semi-closed housing; P1H1: high protein with semi-closed housing.

3.1 Chicken performance at 1-7 days

The research results revealed that the performance of IPB D1 chickens during the starter phases (1-7 days), including consumption and body weight gain, was significantly (P<0.05) higher in chickens given higher protein levels. Chickens provided with higher protein levels showed an average feed intake of 90.89-95.07 grams per chick and a body weight gain of 48.87-50.78 g chick^{-1}, compared to those given lower protein levels, which averaged 82.23-92.43 g chick^{-1} for feed intake and 39.70-46.57 g chick^{-1} for body weight gain. Likewise, the feed conversion ratio (FCR) was found to be better (P<0.05) in chickens fed higher protein by 1.63-1.96 than in chickens fed lower protein by 1.77-2.33.

Regarding the use of different housing systems, the study results demonstrated that the semi-closed housing system yielded better performance (P<0.05) in terms of consumption and body weight gain. In the semi-closed housing system, chickens exhibited a feed intake of 82.23-90.89 g chick^{-1} and a body weight gain of 46.57-50.78 g chick^{-1}, whereas, in the open housing system, these values were 92.43-95.07 g chick^{-1} for feed intake and 39.70-48.87 g chick^{-1} for body weight gain. Additionally, the feed conversion ratio (FCR) was found to be better (P<0.05) in the semi-closed housing system by 1.63-1.77 than in the open housing system by 1.96-2.33.

No mortality was observed among the IPB D1 chickens during the starter maintenance period of 1-7 days.

3.2 Chicken performance at 8-14 days

The performance of IPB D1 chickens during the 8-14 day phase, encompassing both consumption and body weight gain, displayed significant enhancement (P<0.05) in chicks provided with elevated protein levels. Chickens receiving higher protein levels exhibited an average feed intake ranging from 221.05-237.54 grams per chick and a corresponding body weight gain spanning from 120.17-133.01 grams per chick. In contrast, those subjected to lower protein levels showed an average feed intake ranging from 218.89-226.47 grams per chick and a body weight gain ranging from 94.38-106.33 grams per chick. Similarly, the feed conversion ratio (FCR) demonstrated notable improvement ($P<0.05$) in chickens fed higher protein, with values ranging from 1.78-1.84, compared to those fed lower protein, with values ranging from 2.24-2.32.

The findings concerning the diverse housing systems indicated superior performance ($P<0.05$) in the semi-closed housing arrangement concerning consumption and body weight gain. In the semi-closed housing system, chickens displayed a feed intake ranging from 226.47-237.54 grams per chick and a body weight gain ranging from 106.33-133.01 grams per chick. Conversely, in the open housing system, these metrics ranged from 218.89-221.05 grams per chick for feed intake and from 94.38-120.17 grams per chick for body weight gain. Additionally, the feed conversion ratio (FCR) proved superior ($P<0.05$) in the semi-closed housing system, with values ranging from 1.78-2.24, compared to the open housing system, with values ranging from 1.84-2.32.

During the maintenance period spanning 8-14 days, no mortality was observed among the IPB D1 chickens, except for one chick that died in the P1H1 treatment, and apparently, this was not caused by the treatment given.

Table 3. Chicken performance at 8-14 days period

Variables	P0H0	P1H0	P0H1	P1H1
Feed intake (g chick^{-1}day^{-1})	31.27 ± 0.05	31.58± 0.03	32.35± 0.04	33.93± 0.02
Total feed intake (g chick^{-1})	218.89 ± 15.51^{b}	221.05 ± 7.87^{b}	226.47 ± 5.16^{ab}	237.54 ± 4.48^{a}
Body weight gain (g chick^{-1}day^{-1})	6.74± 0.04	8.58± 0.02	7.59± 0.03	8.78± 0.05
Total body weight gain (g chick^{-1})	94.38 ± 9.56^{c}	120.17 ± 2.56^{a}	106.33 ± 5.85^{b}	133.01 ± 3.87^{a}
FCR	2.32 ± 0.1^{a}	1.84 ± 0.04^{b}	2.24 ± 0.09^{a}	1.78 ± 0.07^{b}
Mortality (%)	0	0	0	0.02

P0H0: low protein with open housing; P1H0: high protein with open housing; P0H1: low protein with semi-closed housing; P1H1: high protein with semi-closed housing.

3.1 Oven and semi-closed housing system environment

The open housing system exhibited a lower average morning temperature (26.8°C) and higher relative humidity (76%) compared to the semi-closed housing system (27.8°C, 66%). However, during the day, the open system had a higher temperature (37.4°C) and lower humidity (42%) compared to the semi-closed housing system (32.7°C, 52%). Although afternoon temperatures remained lower in the open system (28.5°C), the relative humidity was higher (71%) compared to the semi-closed housing system (31.2°C, 58%).

The open housing system also displayed a larger range of both temperature (26.8°C-37.4°C) and relative humidity (42%-76%) compared to the semi-closed housing system (temperature: 27.8°C-32.7°C; humidity: 52%-66%). This greater fluctuation in the open system suggests that chickens housed there may have experienced higher stress levels compared to those in the semi-closed housing system. This difference in stress levels might explain the observed lower performance in the open housing system

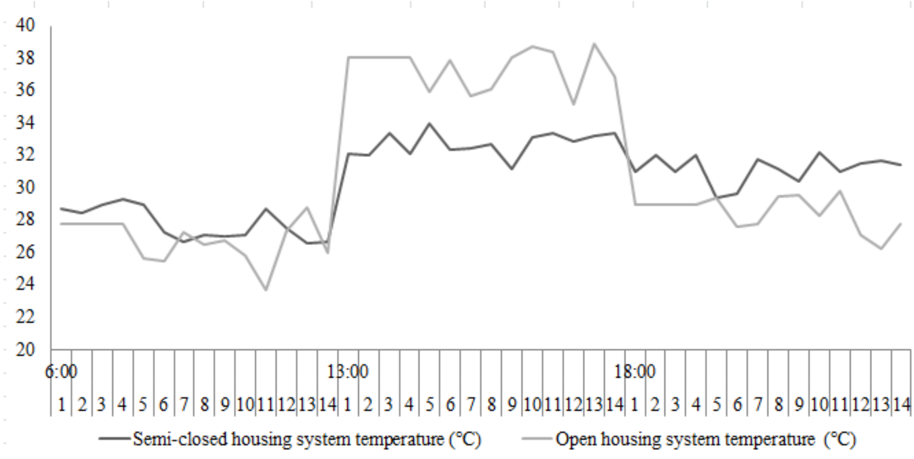

Fig. 1. Open and semi-closed housing system temperature

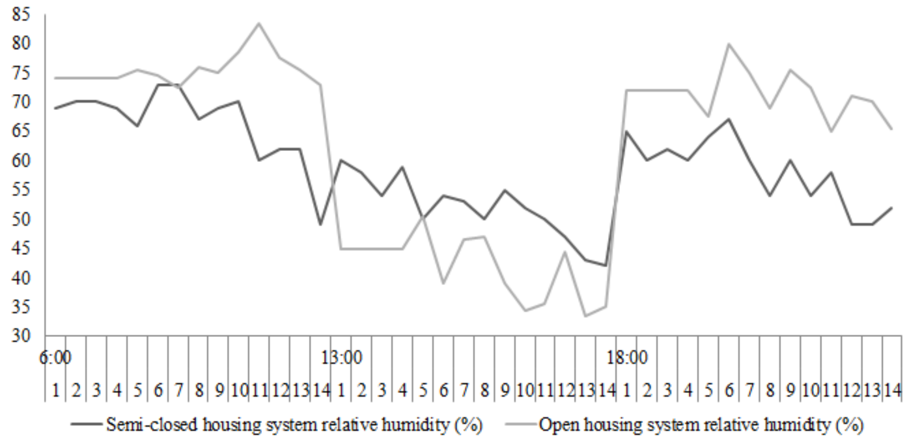

Fig. 2. Open and semi-closed housing system relative humidity

4 Discussion

Rearing with a semi-closed housing system produces lower total feed intake and FCR values compared to rearing in an open housing system. Feeding with a protein level of 22% and rearing using a semi-closed housing system resulted in the lowest FCR value, 1.63 in the 1-7 days period and 1.78 in the 8-14 days period. These current results are in line with the findings of Rezaei et al. [11], who observed that slower-growing hybrid birds exhibited faster growth when fed the high-protein diet compared to the low-protein diet. Since the IPB D1 chicken is categorized as a slower-growing hybrid bird, the findings of Rezaei et al. [7] serve as evidence that the high-protein diet appears to promote faster growth in slower-growing hybrid birds.

Additionally, Widyaratne and Drew [12] reported that low-protein diets could support growth performance equal to high-protein diets when highly digestible ingredients are used. Table 2 and Table 3 show that the total body weight gain value is higher and the FCR value lower on semi-closed housing systems fed with 22% protein content. This can be caused by the greater content of essential amino acids needed for optimal growth compared to feed with 20% protein. Apart from that, with more protein, chicks can synthesize body protein more efficiently. It helps in the formation of muscles and other body tissues, which directly contributes to increased body weight and feed efficiency. Rearing with open housing system will make chicks more easily exposed to infectious diseases and parasites, vulnerable to adverse climatic conditions which can increase stress [13].

Regarding the effect of housing system type on chicken performance, it is consistent with the findings of Qaid et al. [14], who reported that housing systems significantly affected performance. Additionally, Muharlien et al. [13] and Laili et al. [15] reported that the closed-house system yields better results in broiler production in terms of feed intake, body weight gain, and FCR.

5 Conclusion

The enhanced response of IPB D-1 chicks during the starter phase to a diet with 22% protein content and a semi-closed housing system is evident. The performance of IPB-D1 chickens in the starter phase that were fed with 22% protein content and kept in a semi-closed housing system was better than those fed with 20% protein content and kept in an open housing system. This is shown in higher total body weight gain and lower FCR.

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