Production Performance of the Broiler Under Open, Semi-closed, and Closed House Systems During Rainy Season

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Abstract. House is a fundamental pillar that directly affects the success of poultry farms. There are three house systems, namely open, semi-, and closed house systems. Objective of the study was to analyze the performance of the broilers, which are raised in open, semi-closed, and closed houses. The study was conducted from January to April 2019. Materials of the research were 5,000 chickens/unit in an open house; 18,000 chickens/unit in a semi-closed house; and 33,000 chickens/unit in a closed house. The study was survey research in the field. The research used Complete Randomized Design along with 3 treatments and 2 replications. The observed parameters included body weight (BW), feed intake (FI), feed consumption ratio (FCR), index of performance (IP), and mortality. Based on the result of the research on broiler performance, showed a significant difference ($P < 0.05$) in weight but it showed nonsignificant differences in FI, FCR, IP, and mortality. It concluded that poultry raising in the open house showed the best performance based on body weight.

Keywords: Open housed · Semi-closed house · Closed house · Performance

1 Introduction

Broilers are one of the poultries, which is highly effective in producing meat. It has a short raising period and low production cost. The rapid development of broiler productivity is balanced with the rapid development of supporting technology. Industries in this sector grow unstoppable, and Indonesia is no exception. Poultry industries, especially broiler, are the economic base that is highly potential in increasing economic growth and providing wide job opportunities. Poultry industries as the main sector of the national economy have supplied 65% of protein and hired 10% of national workers with an estimation of more than USD 34 billion [1]. The national production of broiler meat in 2020 reached 3.43 million tons [2] and 199.5 million tons at the world level [3].

House is one of the supporting factors toward the success of broiler farming. House is an important part of poultry rearing management where all activities of the poultries take place, and the poultry comfort must be maintained to produce healthy and productive poultry. In general, there are two house systems namely closed house and open housed. In

E. Widodo et al. (Eds.): ICESAI 2022, ABSR 28, pp. 411–419, 2023.
https://doi.org/10.2991/978-94-6463-116-6_51

the open house, 100% microclimate condition of the house is affected by the environment of the house. In the closed house, the microclimate can be adjusted as required. In Indonesia, besides those two house systems, a semi-closed house has developed as well, and this type adopts the previous two house systems.

The closed house system has more advantages than the open house. The advantages include temperature and humidity in the house can be adjusted so that the changes in temperature and humidity can be minimized, and the density of the house is higher (12–14 chickens/m2) than in the open housed (8–10 chickens/m2) [4]. Index of Performance (IP) of broiler farming in the open house ranged from 340–360, while broiler rearing in the closed house reached 400 [5].

Indonesia is a tropical country that has only 2 seasons, and each season lasts 6 months on average. The rainy season lasts around from November to April. Rainfalls are very high during the season. Temperature is relatively cooler, 24°–28 °C, during the day. But, it is slightly warmer at night than during the dry season, 23°–26 °C [6].

Objective of the study was to analyze the broiler performance that includes body weight (BW), feed intake (FI), feed consumption ratio (FCR), index of performance (IP), and mortality of the broilers that are raised an open house (OH), semi-closed house (SH), and closed houses (CH) in the rainy season.

2 Materials and Methods

2.1 Materials

The study was survey research. Materials of the study were broilers of Lohmann strain, platinum grade. The number of broilers put in open, semi-closed, and closed houses was 5,000 chickens/unit; 18,000 chickens/unit, and 33,000 chickens/unit. The observation was conducted on 6 units of houses that comprised 2 units of open houses, 2 units of semi-closed houses, and 2 units of closed houses. Open housed has 100% ventilation that comes from the screen system on the walls and roof of the house. The open house is specified by the size of 40 × 8 × 4 m. it is made of wood and bamboo for the walls and asbestos for the roof. The first floor is grounded and the second floor is made of bamboo covered with tarpaulin.

Semi-closed house is constructed with tunnel ventilation, which is equipped with an exhaust fan to remove dirty air. The semi-closed house is specified by the size of 78 × 8 × 4 m. The wall is built from brick, chicken wire, and asbestos roof, the first floor uses lean concrete and the second floor is made of bamboo covered with tarpaulin. Each floor is equipped with 10 units of fan/floor.

A closed house is built with tunnel ventilation, which is equipped with an evaporative cooling pad and exhaust fan by utilizing a negative pressure system. Specification of the closed house is 120 × 12 × 4 m. The wall is built from brick, chicken wire, and asbestos roof, the first floor uses lean concrete and the second floor is made of bamboo covered with tarpaulin. Each house is a 2-story house with a gable roof. The screens that can be opened and closed surround the 2 sides of the house. The litter material used is a husk with a thickness of 10 cm.

2.2 Feeds

The complete feeds for the broilers are produced by PT. Japfa Comfeed Indonesia Tbk, SB 11 (starter), SB 12 (finisher). A starter ration is given from DOC to the age of 21 days and followed by a finisher ration from the age of 22 days to 35 days. Feeds and drinks are given in ad libitum.

2.3 Observation

Data on temperature (^{o}C) and humidity (RH %) are taken 4 times a day at 06.00, 12.00, 18.00, and 24.00 for 28 days using Thermo-hygro USB Temperature and Humidity Data Logger Model No. DS102. Wind velocity is observed every week using Kestrel 3000 weather meter part #0830. NH_3 is measured every week by putting NH_3 detector of Smart sensor AR 8500 (0-100ppm) on litter. Sample of litter used for E.coli test was taken randomly from the house and followed by MPN test in Laboratory for Pests and Diseases, Faculty of Agriculture, the University of Brawijaya by total samples of 24 units. E.coli litter was observed in the 2nd week and 4th week.

The parameter of the study was the broiler performances that include body weight (BW), feed intake (FI), feed conversion ratio (FCR), index of performance (IP), and mortality.

1. The body weight (g) of the broiler is weighed on 1st day when the DOC comes in on the 7th, 14th, 21st, and 28th days. The sample was derived from 1% out of the whole population and taken randomly.
2. Feed intake (g/chicken) is the difference between the remaining ration and the total rations were given. The remaining feed is weighed every week.
3. The feed conversion ratio is counted by dividing ration consumption and weight gain.

$$\text{FCR} = \frac{feed\ intake(g)}{weight\ gain(g)}$$

4. Index of Performance

$$\text{IP} = \frac{[100 - dead\ chicken\ (100)]x\ average\ weight(kg)}{harvest\ time\ (day)\ x\ feed\ conversion} x100$$

5. Mortality (chicken) is number of the dead chickens, which is recorded everyday and then counted in percent. Mortality of the poultry is recorded every day.

Microclimate, NH_3 and E.coli of each house are presented in Table 1. The house types show significant differences ($p < 0.05$) in temperature, humidity, wind velocity, and NH_3. However, the house types do not show a significant difference in E.coli.

2.4 Data Analysis

Data on body weight (BW), feed intake (FI), feed conversion ratio (FCR), and index of performance (IP) are analyzed using analysis of variance (ANOVA). If any significant difference is found, it will be continued with the least significant different test.

Table 1. Description of microclimate, NH_3 and E.coli in open housed, semi-closed house, and closed house

Week	OH	SH	CH
Temperature (^oC)			
1	28,29 ± 2,73[a]	31,52 ± 2,11[b]	32,25 ± 0,85[c]
2	25,17 ± 2,93[a]	30,14 ± 2,26[c]	29,59 ± 1,09[b]
3	23,72 ± 3,27[a]	29,60 ± 2,98[c]	28,46 ± 1,28[b]
4	22,59 ± 3,85[a]	28,92 ± 3,11[c]	27,17 ± 1,49[b]
RH (%)			
1	54,43 ± 8,73[a]	69,61 ± 5,41[b]	62,25 ± 4,79[c]
2	66,18 ± 9,32[a]	72,98 ± 6,32[c]	66,29 ± 3,61[b]
3	72,52 ± 9,55[b]	76,07 ± 8,34[b]	71,59 ± 4,34[a]
4	74,19 ± 11,27	71,18 ± 7,63	73,66 ± 5,22
Wind Velocity (m/dt)			
2	0,55 ± 0,11[a]	0,56 ± 0,11[a]	0,88 ± 0,16[b]
3	0,68 ± 0,17[a]	0,73 ± 0,24[a]	2,07 ± 0,51[b]
4	0,85 ± 0,11[a]	0,91 ± 0,21[a]	1,89 ± 0,41[b]
NH_3			
2	2,21 ± 1,52[a]	5,44 ± 1,55[a]	8,06 ± 4,89[b]
3	2,54 ± 2,92[a]	11,58 ± 6,38[b]	15,24 ± 8,25[c]
4	8,46 ± 5,64	9,76 ± 5,95	14,44 ± 9,01
E. coli (x 10^2cfu/mL)			
2	4,05 ± 1,32	3,90 ± 1,49	1,50 ± 0,48
4	6,15 ± 2,83	5,35 ± 0,95	5,93 ± 1,19

Notes: Different superscript on the same line show significant different ($p < 0.05$)

3 Results and Discussion

3.1 Effect of the House Types on Body Weight in Rainy Season

The growth of broilers is as a result of interaction between 30% genetic factors and 70% environmental factors [7]. The broilers' performance is highly determined by environment where they live started from doc to be harvested or rejected. The house comfort is the absolute requirement to achieve optimal productivity. Based on data in Table 2, they show that, in general, house types affect on body weight (BW) ($P < 0.05$). At 1st day (entry) the doc weight were considered to be equal, ranged from 44.61 ± 4.62g to 44.87 ± 3.65 g. Rearing was begun with the same weight as they derived from the same grade and strain, platinum grade of Lohmann. During their growth at the 7th to 14th day, their weights were heavier, in open housed and semi-closed houses, than in the closed house. At the 21st day, the broiler weights were the highest in semi-closed and closed houses.

Table 2. Effect of the house types on body weight

Age (day)	BW (gr)		
	OH	SH	CH
1st	44,49 ± 3,50[a]	44,87 ± 3,65[a]	44,61 ± 4,62[a]
7th	197,39 ± 20,31[b]	198,87 ± 37,96[b]	166,18 ± 27,03[a]
14th	532,20 ± 53,06[c]	481,26 ± 93,89[b]	470,66 ± 58,38[a]
21st	1.017,20 ± 97,23[a]	1.066,10 ± 152,72[b]	1.114,90 ± 161,23[c]
28th	1.566,50 ± 169,76[b]	1.398,80 ± 278,79[a]	1.528,30 ± 193,16[b]

Notes: Different superscript on the same line shows significant difference ($p < 0.05$)

At the 28th day, the broiler weights were the highest in the open and closed house. In general, the open housed produced the best weight.

Rearing in the closed house showed different weight in comparison with in open houses on the 1st–7th day, with the difference of 20.05%, 18.08% at 8th–14th day, 14.42% at 15th–21st day, 26.48% at 22nd–28th day, and 23.24% at 29th–35th day [8]. Semi-closed house technology was able to support the broiler production for consumption of 3,051.52 ± 241.24 g, final weight was 1,956.37 ± 95.88 g, feed conversion was 1.5 ± 0.07, index of performance was excellent (359.78 ± 1.87) [9]. The broiler weights on those three house types above have conformed to the standard.

The low weight of the broilers in the closed house at the age of 7 and 14 days may due to different densities in the house. In the closed house, the density was 20 chicken/m^2 at the age of 7 days, while in open and semi-closed houses, the density was 30 chicken/m^2. Lower density was intended to make the broilers will be able to adapt to wind velocity as a part of the cooling system/circulation in the closed house. Wind velocity above the requirement is presumed to be the cause of the lower weight of the broilers in the closed house. At the age of 14 days, density in the closed house was 17 chicken/m^2, and 13 chicken/m^2 in open and semi-closed houses, which means that higher density is found in the closed house. It caused the highest NH_3 8.06 ± 4.89 ppm in the second week at the closed house. High NH_3 negatively affects on the broilers [10, 11], declines the growth and performance of the poultry, decreases resistance, and increases mortality of the poultry [12].

3.2 Feed Intake

Consumption is determined by activities and temperature in the environment [13]. Feed intake closely relates to weight gain, so factors that affect ration consumption and weight gain will also affect ration conversion [14]. The temperature of the environment may affect the consumption rate as shown by the decrease of ration consumption when environmental temperature increases.

Based on Table 3, FI on the results of the research does not show a significant difference. The broiler productivity, including body weight, FI, FCR, mortality, and IP do not affect the house types [15]. It was presumed that the broilers have the same

Table 3. Effect of the house types on FI, FCR, IP, and mortality in rainy season

Parameter	OH	SH	CH
FI (kg)	2,28 ± 0,14[a]	2,32 ± 0,04[a]	2,13 ± 0,06[a]
FCR	1,46 ± 0,03[a]	1,60 ± 0,03[a]	1,42 ± 0,03[a]
IP (%)	363,50 ± 4,95[a]	322,50 ± 24,75[a]	369,50 ± 4,95[a]
Mortality (%)	3,59 ± 0,95[a]	4,19 ± 0,28[a]	1,93 ± 0,01[a]

Notes: Different superscript on the same line shows significant difference($p < 0.05$)

genetic, feed, and raising management. The feed consumptions of the broilers were not significantly different in a closed house and open housed, whereas the closed house was 2.53 g/chicken and open house was 2.24 g/chicken at 5 weeks [16].

3.3 Feed Conversion Ratio

FCR is the amount of feed given to the broilers to produce 1 kg of live weight. A lower value of FCR indicates that the broilers are getting more efficient in utilizing feed nutrition. If the FCR value is higher than the standard, it indicates that it wastes the feed due to the utilization for the broilers' weight gain has not optimal.

Results of the research are presented in Table 3, in which FCR values are not significantly different statistically. FCR values, from lower to higher values, were derived from the closed house, open house, and semi-closed house, which counted at 1.46 ± 0.03; 1.60 ± 0.03, and 1.42 ± 0.03, respectively. FCR values in this study were excellent. Broiler raising is still efficient if the feed conversion is below 2 [13]. The FCR values were derived from the environmental temperature in the house, which means that the lower the environment of the house, the higher the FCR values will be gained [17]. The FCR of the broiler was 1.7 [18]. FCR in the closed house was 1.78 and opened house was 1.62 [16]. The average feed conversion ratio (FCR) on broiler farming with a closed house system pattern was 1.60 and on the open house system was 1.77 [19]. The average FCR on Close House was 1.554 and on Open House was 1.578 [20].

3.4 Index of Performance

Criteria used to find out the success in poultry rearing is counting the index of performance. Index of Performance (IP) is a formula, which is commonly applied to find out the broiler performance. The higher the value, the better the performance of the broiler is and the more efficient the use of feed. The index of performance is counted by following the average weight of the broiler, which is ready to be butchered, feed conversion, harvest time, and percentage of live broilers during the rearing [21]. The assessment results of the production performance are useful for evaluation in the final period and the evaluation results will be used to decide on the next period of rearing.

IP values in Table 3 do not statistically show a significant difference. IP values from the highest to the lowest are shown by the closed house, open house, and semi-closed house has 369.50 ± 4.95; 363.50 ± 4.95, and 322.50 ± 24.75%, respectively.

The performance of the broilers in the open house was 340–360 and 400 in the closed house [5]. IP values that ranged from 351–400 indicate the excellent performance of the poultry, and below 300 are considered worse [22]. Mortality.

One of the factors that affect the mortality percentage is temperature. Cold weather during the brooding period, and the ventilation systems in broiler raising function to reduce ammonia that may disturb production. Besides that, respiratory disease often occurs at the age of two to three weeks due to the accumulation of ammonia in the house when the environment reaches a high temperature [23]. Mortality at high temperatures may reach 30% of the total population [24].

Table 3 shows that house types do not affect mortality. The mortality rates from the lowest to the highest derived from the closed house, open house, and semi-closed houses, were 1.93 ± 0.01; 3.59 ± 0.95, and $4.19 \pm 0.28\%$. Mortality in the closed house was 13.03% and in the open house was 7.68% [16]. Broiler mortality in an open house ranged from 1.9 – 4.8%, and in a closed house ranged from 0.9 – 3.3% [25]. Mortality is a factor that affects the success of poultry farms. The broiler mortality frequently occurs in the early period or starter and gets lower in the final period or finisher. The mortality percentage during the raising period should not be more than 4%. The mortality rate during the first week should not be more than 1%, the subsequent mortality should be relatively lower by the end of the week and keep constant until the final raising period [26].

4 Conclusions

The conclusions indicated that poultry raising in the open house showed the best performance based on body weight.

Acknowledgment. Special thanks to Directorate General of High Education, Ministry of Research, Technology, and Higher Education for BPPDN scholarship to fund the research and PT. Ciomas Adisatwa, Tbk that had facilitated the research.

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