Microclimate Analysis of Opened House and Closed House in Broiler Rearing

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Abstract. This study aims to analyse the microclimate of opened house and closed house in broiler rearing. The research location was Sumber Rejo Village, Gedangan District, Malang City. The number of CP 707 broiler strains in the opened house was 8,000 and 16,000 in closed house. Microclimate data collected were temperature (°C) and relative humidity of the cage (percentage), and air speed (feet/minute). The instrument used was thermohygro with sensors that can record data automatically and air speed measured to determine parameters of the rearing period. The temperature and humidity data of the house measured periodically on 06.00 a.m., 12.00 a.m., and 18.00 a.m. Data collected for 35 days of the rearing period, starting on September 13th until October 18th, 2019. Data tabulated and analysed using unpaired t-test. Based on the analysis results there were not significant differences in the temperature and relative humidity of opened and closed house air during daytime observations (P>0.01). There was a significant difference in viscosity (P<0.05) within house systems. It is suggested to do further research about effect of house system on broiler performance.

1. Introduction

The success of poultry farming, especially broilers, depends on three aspects, breeding, management, and feed. Broilers are the most efficient in converting feed into livestock derivative products as supported by good management. Housing system is one aspect of management, which has a very important role to ensure optimal production processes.

Generally, the housing system developed in Indonesia is an open cage and closed cage. The decision to choose a cage system based on the capital and environment in which the cage built. Closed house, generally owned by companies with substantial capital and maintenance scale. In a closed cage system the microclimate in the cage can be adjusted as needed while in an open cage (open house) the microelements in a cage depend on the natural conditions around the cage environment [1]. These differences will affect the microclimates in the cage. Microclimates in closed house designed and controlled to meet the comfort zone for the maintenance of broilers.

Microclimates in the cage include temperature, humidity, air velocity and movement, air composition, and light [2]. Broilers have certain microclimate needs according to their physiological development and production phase [3]. Broiler types of starter period require environmental temperature is 29°C-32°C, whereas in the finisher period requires 23°C-28°C [4].
Differences in the construction of open and closed enclosures will give a microclimate difference to the internal environment. This study examines the microclimate differences between open and closed cage systems at various observations.

2. Materials and methods

2.1. Location and Birds
This research carried out at Sumardi’s farm located in Kademangan Village, Pagelaran District, and Malang City. Ambient temperature was 27 °C-29 °C. Research location was 500-1000 Mean Sea Level. This research carried out during starter and finisher period phase period, starting on September 13th until October 18th, 2019. Owner was on partnership with PT. Japfa Comfeed Indonesia.

The birds were CP 707 strain produced by PT. Charoen Pokphand Indonesia. Feed was complete feed code 511 (starter period) and code 512 (finisher period) produced by PT. Charoen Pokphand Indonesia Tbk.

2.2. House
Specifications of opened house was 8 x 80 m in size, without curtains, consisting of two floors (double deck), gable type roof, height of the cage was 4 m (first floor 1 and second floor). Litter material is a rice husk with a height of 10 cm in the brooding period. House material is bamboo. Stock density was 8 birds/m².

Specifications of closed house was 8 x 80 m in size, with curtains, consisting of two floors (double deck), gable type roof, height of the cage was 4 m (first floor 1 and second floor). Litter material is a rice husk with a height of 10 cm in the brooding period. House material is bamboo. Stock density was 16 birds/m².

2.3. Method
The research method is an experiment to test the differences in the microclimate (include temperature, relative humidity, and air viscosity) of opened house and closed house. Data analyse is a t-test (t-student). The research variables are temperature (°C), relative humidity (percentage), and air velocity (feet/minute). Air temperature and humidity observed and recorded at 00.00 WIB, 06.00 WIB, 12.00 WIB, and 18.00 WIB. The tool for measuring temperature and humidity is thermo-hydro USB Temperature and Humidity Data Logger Model No. DS102. Air velocity measured using a Kestrel 300 Weather Meter part # 0830.

3. Result and Discussion

3.1. Result
Average microclimate parameter, temperature(°C), relative humidity (%), and air viscosity (feet/minute) presented on Table 1.

| Table 1. Micro-climate parameter average, temperature(°C), relative humidity (%), and air viscosity (feet/minute) |
|---------------------------------------------------------------|
| Parameter | Opened House | Closed House | Sig. (2-tailed) |  |
| Temperature (°C) | 27,78±0,25 | 27,23±0,27 | 0,137 |  |
| Relative humidity (%) | 58,34±0,85 | 60,65±0,78 | 0,055 |  |
| Air velocity (feet/minute) | 38,83±3,67 | 152,40±7,51 | 0,000 |  |

Note: Average±SE, significant level 95% (P<0.05)
Microclimate parameters average, temperature (°C), relative humidity (%), and air velocity (feet/minute) observed on 06.00 am, 12.00 am., and 18.00 am. presented on Table 2.

Table 2. Microclimate parameters average, temperature (°C), relative humidity (%), and air velocity (velocity) (feet/minute) observed on 06.00 am, 12.00 am., and 18.00 am.

| Parameters               | Time observed | Sig.   |
|--------------------------|---------------|--------|
|                          | 06.00 a.m.    | 12.00 a.m. | 18.00 a.m. |
| Temperature (°C)         | 26,20±2,62a   | 29,11±1,63c | 27,50±2,69b |
| Relative humidity (%)    | 58,34±0,85a   | 60,65±0,78b | 59,45±8,40b  |
| Air velocity (feet/minute)| 38,83±3,67a   | 152,40±7,51b| 87,42±6,56a  |

Note: Mean±Std. deviation, superscript on the same row shown significant difference (P<0.05)

3.2. Discussion

Farmers or modern broiler farming businesses must be able to realize the appropriate environmental conditions to be able to maximize the genetic potential of birds, pay attention to the most important factors in housing management, and understand the basic guidelines for operating the housing system [4]. The types of house, commonly used by farmers in Indonesia are closed house and opened house. The decision of choosing house type has an effect on broiler productivity. There is a correlation between temperature, humidity, and air velocity. Based on the results of statistical analysis, there is no difference in the environment temperature of the open ed house and closed house. The average temperature of a closed house was 27.78 °C while that of an opened house was 27.23 °C. The house designed to produce microclimates to maximize the appearance of bird’s production, achieve optimal growth uniformity, feed efficiency for carcass production, and ensure the health and welfare of birds during maintenance [4].

Each strain of broiler has special rearing standards. Farmers must understand a number of things, include: criteria for environmental conditions needed to optimize the genetic potential of modern broilers. Factor that influence house construction. House construction must be able to create optimal environmental conditions for the maintenance of modern broilers. In addition, workers must also understand the operational guidelines of the house. Generally, farmers in Indonesia choose the construction of open and closed type [5]. The standard environmental temperature changes during the maintenance period, around 30°C at brooding period and 20°C at finishing period, depending on the bird’s size and other factors. Ventilation must adjusted to maintain optimal temperatures. Ambient temperature depends on ambient temperature and humidity. The ideal RH is 60-70%. Whether ideal air humidity was not reached, the temperature level in the house must be adjusted. For example if RH reach 50%, the ambient temperature must adjusted to 33°C [4]. Ventilation is the most important tool in managing the enclosure environment to produce optimal production performance. Ventilation is a practical way to lower and increase air humidity. This condition is a problem faced when there is a lot of wind and can affect the health of livestock. When ventilation did not needed to move hot air, a minimum air rate maintained to avoid the rate of humidity, litter that flies in the house, and problems related to ammonia gas [4]. These control mechanisms did not found in opened type enclosures. In construction, a closed system house divided into two systems namely the first tunnel system with several advantages it has such as relying on wind flow to remove residual gas, heat, water vapor and provide oxygen for chicken needs. This tunnel system is more suitable for areas with a maximum temperature of not more than 30°C. The second system is the evaporative cooling system (ECS). This system provides benefits to farmers such as relying on wind flow and the process of evaporation with the help of wind. This closed closed system is only suitable for hot areas with temperatures above 35°C [6]. Many closed house systems have advantages rather than opened house. The advantages such as the temperature and humidity situation in the house can be adjusted so that changes in temperature and humidity are reduced, the density of the cage is higher (12-14 birds/m²)
compared to open ed house (8-10 birds/m²) [7]. Temperature observation graphs at 06.00 a.m., 12.00 a.m., and 18.00 a.m. presented in Figures 1.

![Temperature observation graphs at 06.00 a.m. (a), 12.00 a.m. (b), and 18.00 a.m. (c)](image)

Figure 1. Temperature observation graphs at 06.00 a.m. (a), 12.00 a.m. (b), and 18.00 a.m. (c)

Based on the results of statistical analysis, there is no difference in air humidity in open ed house and closed house. The average relative humidity of closed house is 60.65% while in open ed house is 58.34%. The relative humidity (Rh) observation graphs at 06.00 a.m., 12.00 a.m., and 18.00 a.m., presented in Figures 2.

![Relative Humidity (Rh) observed at 06.00 a.m. (a) and 12.00 a.m. (b)](image)
Based on the results of statistical analysis, there are differences in air velocity in open and closed houses. The average air velocity in a closed house is 38.83 feet/minute while in an open house is 152.40 feet/minute. Graphs of air velocity at 06.00 WIB, 12.00 WIB, and 18.00 WIB are presented in Figures 3.

In the climate data obtained in [8], there is an effective temperature output value with many combinations of certain inputs. It is known that those three parameters are not independent. As a result, it can cause a problem in determining how much effective temperature required that’s always obtain dynamic value from the changes of time to keep ideal the house climate. If this value is too large, it will cause the problem that broilers will suffer from the heat because of less of the wind speed that flows from the exhaust fan. But instead, the chicken will suffer from the cold while the wind speed is too fast.
Therefore, a predictive process for effective temperature is needed to estimate how much it required for maintain the climate in a fast area.

The findings indicated that the production performance of the climate controlled system (CCS) houses under small, medium, and large had better-feed conversion ratio compared to conventional house type with a significant difference. CCS farms had better productivity, which explained by better growing conditions for the birds. It is recommended that CCS houses be established so as to maintain the conducive conditions for bird growth [9].

4. Conclusion
There is no difference in temperature and internal air humidity in opened and closed house, but there is a difference in air velocity. There are differences in temperature, humidity, and air velocity at difference time observation.

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