Production Performance of Layer Strain Hy-Line Brown in Different Cage Locations in Closed House

Edhy Sudjarwo[1], *Muharlien* Muharlien[1], *Osfar* Sjofjan, and *Dyah* Lestari Yulianti[1*]

[1]Animal of Animal Science, Universitas Brawijaya, Malang 65145, Indonesia

Abstract. The aim of this study was to determine the production performance of layer hen strain Hy-Line Brown in different cage locations in closed house. The research material was 5,051 laying hens of the Hy-Line strain aged 28 weeks. House system was closed house, cage arranged to form frame A. Hy-Line Brown layer were housed at cage densities of 500 cm^2 per hen. Research feed is complete feed code 324 KJ produced by PT. Charoen Pokphand Indonesia. The research method is comparative, comparing the production performance on the location of the cage in zone 1 (inlet), zone 2 (middle), and zone 3 (outlet) of a closed cage. The research sample is 10% of the total population. Observations were carried out on 6 cages which were randomly selected in each cage zone. The average density of cages is 20 birds/m^2. Tabulated research data are Hen Day Production (%), egg weight (g), egg mass (kg), and feed conversion. Data analysis is analysis of variance analysis (One-Way ANOVA). Based on the results of the study, there were significant differences in the the production performance of layer hen strain Hy-Line Brown in different cage locations in closed house. The highest production performance is the cage located close to the inlet (Zone 1).

1 Introduction

The house is an important part of the management of laying hens, because it is a place for all birds' activities so that the comfort of livestock must be guaranteed in order to obtain healthy and productive livestock. If kept in poor environmental conditions, birds cannot show performance that is in accordance with their genetic potential, which means a loss [1]. To anticipate unstable climatic factors, currently in Indonesia, closed house are widely used. A closed house system is a type of cage that has good air ventilation settings with the help of an automatic control panel.

The closed house system has ventilation that uses the pressure generated by the fan (exhaust fan) and a cooling pad as the cooling system [2]. The closed house has zoning inside, i.e. the zone close to the cooling pad/inlet, the middle zone and the zone close to the exhaust fan/outlet. The distribution of air flow, temperature, and humidity in the house will

* Corresponding author: dyahlestariyulianti@gmail.com

be different from the point of inlet to outlet (exhaust fan) [3]. Where the zone near the cooling pad has a lower temperature than the zone near the exhaust fan, the house zone near the inlet has a cooler temperature [4]. Differences in the house environment which include temperature, humidity, and air velocity result in differences in the effective temperature of laying hens at the inlet to outlet points [4].

Environmental temperature is the main non-genetic factor that affects the genetic potential of the layer [5]. Temperature is one of the most important environmental factors that can affect the health, behaviour and productivity of poultry [6]. Poultry behaviours can significantly affect its growth [7]. Different temperatures will affect the production activity and the quality of the eggs produced. Egg production is very susceptible to heat stress problems because of concentrated feeding and laying hens are mostly raised in cages with high stocking densities [8]. Killic and Simsek [9] stated that heat stress significantly reduces productivity due to reduced feed intake, reduced feed conversion, higher mortality, reduced egg production, lower egg shell quality, and smaller egg size.

The aim of this study was to determine the production performance of layer hen strain Hy-Line Brown in different cage locations in closed house.

2 Materials and methods

2.1 Animal, hen house, and feed

Animal in this study were 5,051 laying hens of the Hy-Line strain, aged 28 weeks. Research feed is complete feed code 324 KJ produced by PT. Charoen Pokphand Indonesia. House was a closed house with dimensions of 4 x 80 meters equipped with automatic feeding, drinking and egg collection equipment, located in Sumber Sekar Village, Dau District, Malang Regency. Birds are kept in cages/battery in house with a layout as shown in Figure 1. The research sample is 10% of the total population. Observations were carried out on 6 cages which were randomly selected in each cage zone. The average density of cages is 20 birds/m^2.

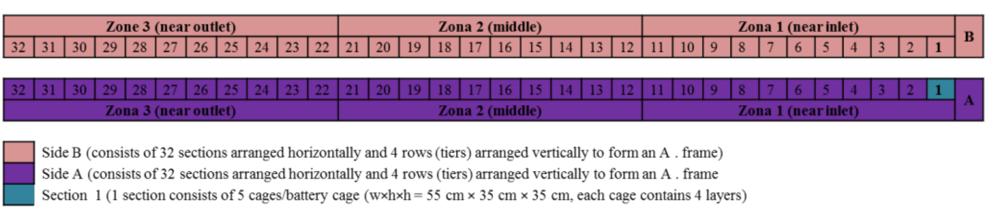
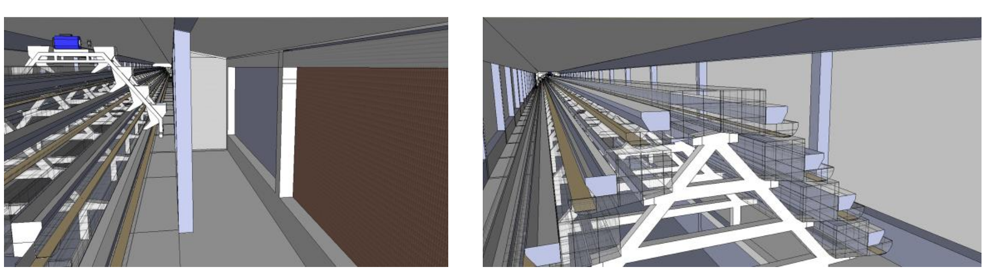


Fig. 1. Lay out cage/battery in closed house



(a) (b)

Fig. 2. Cage layout (a) cages layer section A, (b) cage layer frame A

2.2 Method

Data was collected through observation of birds samples in each experimental unit. Microclimate data obtained by direct measurement using a thermohygrometer. Data that is recorded every day is climatic data including: temperature (°C) and humidity (%).

Layer productivity parameters include HDP (%), egg mass (kg), and observed for 1 month. Hen Day Production (HDP) is the calculation of egg production based on the number of layers per day (daily production = Hen day egg production), number of eggs (n) of layer groups on that day (m) in percentage. The HDP formula is as follows:

$$HDP = \frac{n}{m} \times 100\% \quad (1)$$

Egg quality is egg yolk weight (g) and Haugh Units.

Albumin consistance are calculated base on HU (Haugh Unit). The HU formula was as follow:

HU = 100 log ($H+7.57-1.7W^{0.37}$)
H =Albumin height (mm)
W = Egg weight (g)

The data were subjected to an analysis of variance (ANOVA) using SPSS 16.0 software for Windows (SPSS Inc. Chicago,IL.USA). The differences between group were determined by Duncan's multiple-range tests. All value were presented as means and standard error of the mean, and significance level were set as $P<0.05$ and $P<0.01$.

3 Results and Discussion

Microclimate data in different house zones are presented in Table 1.

Table 1. Microclimate data in different house zones

Parameters	Letak Cage			*Sig.*
	Zone 1	Zone 2	Zone 3	
Temperature (ºC)	24.83±0.70	25.53±1.14	25.85±1.17	0.247
RH (%)	73.83±4.83	72.00±5.51	68.00±7.20	0.252

Note: Mean± std. Deviation

Based on the results of statistical analysis, the microclimate in the three closed house zones laying hens strain Hy-Line strain rearing showed no difference, although numerically there was an increase in temperature from zone 1, zone 2, and zone 3. In line with research [2] which states that measurements from morning to evening show that the temperature will increase from the location of the house in front (inlet) to the location of the house behind (outlet). Yani et al. [3] stated that the position near the cooling pad is cooler because it is the first area to receive cold air that enters through the cooling pad. The cold air that enters through the cooling pad due to being sucked in by the fan at the end of the cage causes the air to move directly to the fan because it has a greater pressure. This condition causes the cold air that enters through the cooling pad to move continuously towards the fan and cools the cage so that the closer to the fan the air is higher than the position near the cooling pad.

According to Primaditya [10], closed house type have advantages such as birds that are not easily stressed due to extreme temperature changes from outside the house and humidity and temperature inside the cage that can be adjusted. The results showed that the highest humidity was in zone 1 and the lowest was in zone 3, but the relative humidity value was still in the standard range of layer period laying hens. According to Yuwanta [14], the ideal humidity for laying hens is 60-70%.

Based on the results of statistical analysis, the effect of different cage locations on the performance of laying hens of the Hy-Line strain, including Hen Day Production (%), egg weight (g), egg mass (kg), and feed conversion is presented in Table 2.

Table 2. The effect of different cage locations on the performance of laying hens of the Hy-Line strain, including Hen Day Production (%), egg weight (g), egg mass (kg), and feed conversion

Parameters	Cage Location			*Sig.*
	Zone 1	Zone 2	Zone 3	
HDP (%)	87.80 ± 1.05^{c}	82.73 ± 0.40^{b}	80.37 ± 3.90^{a}	0.000
Egg weight (g)	63.50 ± 3.16^{b}	64.50 ± 3.25^{b}	59.75 ± 2.30^{a}	0.010
Egg mass (kg)	82.27 ± 2.28^{c}	73.38 ± 0.90^{b}	69.22 ± 5.81^{a}	0.000
FCR	2.63 ± 0.08^{a}	2.97 ± 0.05^{b}	3.17 ± 0.08^{a}	0.000

Note: Week of age 28
Mean± std. deviation
The superscript on the same line shows the difference between treatments with a 95% and 99% significance level ($P<0.01$ and $P<0.05$)

The production parameters includes hen day production and egg weight. The average results of the effect of different cage locations on egg production performance are presented in Table 2. The results of statistical analysis showed a very significant difference in cage location on hen day production, egg mass, egg weight, and feed conversion ($P<0.000$). Based on the performance standard of Hy-Line Brown [11], laying hens of the Hy-Line Brown strain aged 28-29 weeks had an average egg production of 94%. Hen day production is one of the variables measured to determine the size of the level of layer egg production. The results of statistical analysis showed that the HDP at the location of each cage was significantly different. The average egg production at the front house (Zone 1) was the highest when compared to other treatments.

The productivity of modern laying hens varies greatly depending on breed, environmental factors, and disease. The factor that greatly affects production is heat stress. The heat stress will have an impact on the efficiency in converting feed into poultry products [16]. Heat stress is the most detrimental thing in a poultry business, especially for poultry in the high growth and production phase because in that phase the poultry has a high metabolic rate. The main effect of heat stress is a decrease in feed consumption. This is a consequence of the inability of birds to tolerate heat stress. Heat stress can be anticipated through several mechanisms, including sweating, panting, increasing the body area for the evaporation process [17].

Based on the results of the study, the average environmental temperature of the cages in zones 1, 2, and 3 was 24.83 ºC, respectively; 25.53 ºC; and 25.85 ºC. The further away from the inlet, the higher the temperature of the cage. The temperature of the cage in the appropriate layer period is 18-20 ºC, then it is increased by 1 ºC every 2 weeks until it reaches 25ºC. The temperature regulation in the cage must be equipped with a ventilation system that functions to maintain air quality at a certain temperature [11]. Lower temperatures after the peak production phase will trigger an increase in feed consumption so that it can fail to achieve production targets including egg weight, feed efficiency, and adult body weight. Meanwhile, high environmental temperatures will have an impact on decreasing feed consumption and increasing drinking water intake. This resulted in non-fulfillment of food intake so that the production target was not achieved.

High ambient temperature causes birds to carry out effective regulatory mechanisms, such as increased respiration rate. Optimal and efficient production is a combination of low feed intake and optimal egg production (total production). Generally, if the temperature increases, there will be a decrease in feed consumption and egg weight. The parallel impact caused by a decrease in feed consumption is a change in drinking water intake. The increase in environmental temperature will increase the consumption of drinking water.

The hormonal system and metabolic processes change due to heat stress. Heat stress is a sign of the start of changes in chemical reactions in the body. Changes that occur due to an increase in environmental temperature are a decrease in thyroid hormone secretion (although feed intake is maintained through a force-feeding mechanism) and a change in insulin and growth hormone secretion occurs. During prolonged heat stress, the secretion of hormones that play a role in anabolism and catabolism processes will decrease. The decrease in hormone secretion that plays a role in the anabolism process will reduce the efficiency and utilization of food substances that can be digested. This can result in production targets not being achieved.

Based on the results of statistical analysis, the effect of different cage locations on the egg quality of Hy-Line strain layer, including egg yolk weight (g) and Haugh Units is presented in Table 3.

Table 3. The effect of different cage locations on the egg quality of Hy-Line strain layer, including egg yolk weight (g) and Haugh Units (HU)

Parameters	Cage Location			*Sig.*
	Zone 1	Zone 2	Zone 3	
Yolk weight (g)	16.63±0.92	16.25±0.89	16.12±0.64	0.463
HU	70.04±2.83^{a}	77.14±5.76^{b}	76.20±7.78^{b}	0.048

Note: Mean± std. deviation
(P<0.05)

The superscript on the same line shows the difference between treatments with a 95% and 99% significance level (P<0.01 and P<0.05)

The microclimate environment of the house can affect the quality of the eggs produced. The average results that there weren't significant difference of cage location on egg quality which are presented in Table 3. measurement of egg quality will show interactions between treatments on egg white height, haugh unit, and shell thickness [12].

Haugh unit (HU) is a parameter of egg interior quality which is calculated based on albumen height and egg weight [13]. The higher the HU value, the higher the egg quality and the better the albumin quality. The difference in the microclimate of each cage with a different location affects the Haugh unit value. The value of HU at each cage location is good in zones 2 and 3.

With the right supply of feed in quality and quantity, poultry is not infected with disease, and neutral environmental temperature conditions will produce eggs with relatively constant physical composition and size. When the nutrient content does not meet the needs, the layer will make adjustments in several ways, namely reducing the size and or some eggs produced but the chemical composition of the product is maintained. Another adjustment method is through the mechanism of modifying the chemical composition of the product while maintaining production or changing the size, number, and composition of eggs. The evoked response depends on the intake of nutrients that are related to the physiology of egg formation [17].

Albumin quality is related to consistency, addition, and functional properties. Albumin quality is measured by Haugh Units (HU) which is calculated from albumin height and egg weight [18]. The minimum value that can be accepted by consumers is 60. Most eggs produced from animal husbandry should have a HU value of 75-85 [18]. Egg white consistency is influenced by poultry age, genetics, age and shelf life of eggs, vanadium mineral content in a feed, and disease. Poultry with high egg production tends to produce fewer eggs with thick egg whites [19]. This statement explains the results of the study which showed that there was a negative correlation the higher the egg production, the lower the HU value.

4 Conclusions

Based on the results of the study, there were significant differences in the performance of production and egg quality of laying hens strain Hy-Line at different cage locations in closed house. The highest production performance is the cage located close to the inlet (Zone 1).

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References

1. J. J. R. Feddes, E. J. Emanuel, M. J. Zuidhof, Poult. Sci. **81,** 774-779 (2002)
2. D. T. Amijaya, A. Yani, Rukmiasih, Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan. **6**(3),98-103 (2018)
3. A. H. Yani, Suhardiyanto, Erizal, B. P. Purwanto, Med Pet. **37**, 87-94 (2014)
4. Renata, T. A. Sarjana, S. Kismiati, Jurnal Ilmu-Ilmu Peternakan **28**, 183-191 (2018)
5. A. O. Oguntuji, O. M. Alabi, World Poultry Science Journal. **66** (2010)
6. A. B. Webster, M. Czarick, Journal of Applied Poultry Research. **9**, 118-129 (2000)
7. D. P. Neves, T. M. Banhaji, I. A. Naas, Brazilian Journal of Poultry Sci. **16**, 1-6 (2014)
8. X. Tong, S. W. Hong, L. Zhao, Biosystems engineering **30**, 1-15 (2018)
9. I. Killic, E. Simsek, Journal of Animal Veterinary Advances. **12**, 42-47 (2013)
10. F. M. Primaditya, S. Hidanah, Soeharsono, Agroveteriner, **3**, 99-106 (2015)
11. Hy-Line, Management Guide Commercial Layers Hy-Line Brown (2018)

12. L. Komalasari, Dampak suhu tinggi terhadap respon fisiologi, profil darah dan performa produksi dua bangsa ayam berbeda, Tesis, Institut Pertanian Bogor, Bogor (2014)
13. K. M. Keener, K. C. McAvoy, J. B. Foegeding, P. A. Curtis, K. E. Anderson, J. A. Osborne, D. J. Bush. Poultry Science. **85**, 550-5 (2006)
14. SPSS 16.0,. Statistical Package in Social Sciences for Windows (Statistical Innovations Inc., Chicago, USA, 2010)
15. T. Yuwanta, *Telur dan Kualitas Telur* (Universitas Gajah Mada Press, Yogyakarta, 2010)
16. L. G. Cavalchini, S. I. Cerolin, R. I. Marian, Environmental influences on laying hens production. In: Sauveur B. (Ed.). L'aviculture en Méditerranée. Montpellier: CIHEAM. Options Méditerranéennes. Série A. Séminaires Méditerranéens. 153-172 (1990)
17. J. A. F. Rook, P.C. Thomas, *Nutritional Physioloy of Farm Animals* (Longman Inc., New York, 1983)
18. J. A. Coutts, G. C. Wilson, *Egg Quality Handbook* (Queensland Department of Primary Industries, Australia, 1990)
19. J. E. Jones, J. Solis, B. L. Hughes, D. J. Castaldo, J. E. Toler, Poultry Science. **69**, 378-387 (1990)