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THE EFFECT OF DIFFERENT ZONING IN A CLOSED-HOUSE CAGE ON MICROCLIMATE CONDITIONS AND BROILER PERFORMANCE

Sitti Rahmawati[1)], Selvy Mozin[1)], Andi Pertiwi Damayanti[1)], Ummiani Hatta[1)], Sri Sarjuni[1)] and Moh. Asril Adjis[1)]

[1)] Study Program of Animal Husbandry, Faculty of Animal Husbandry and Fishery, University of Tadulako, Palu

Author coreponden : Selvy Mozin
E-mail: selvymozin68@gmail.com

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ABSTRACT

Closed-house cages have zones in them that have different conditions. Zoning in cages has different temperatures, humidity, speed, and ammonia levels and affects broiler performance. This study aims to determine the effect of different zoning on microclimate conditions and broiler performance in closed-house cages. This research was carried out from June 9, 2023 – to July 6, 2023, at the closed-house cage "Chicken Farm Janna" in Taipa Village, North Palu District, Palu City, Central Sulawesi Province. This study used 396 broiler samples aged 1-28 days with a DOC (Day-old chick) weight of ± 37 grams/head. The strain used is Lohman produced by PT. Japfa Comfeed Indonesia. This study used a t-test with 2 treatments and 9 repeats. The treatment studied is Z1 = Zone 1-60 meters from the inlet and Z2 = Zone 60-120 meters from the inlet. The results of the t-test show that different zoning has a significant influence (t count >t table) on microclimate conditions and broiler performance in closed-house cages. Different zoning exerts a real influence on microclimate conditions and the performance of broilers in closed-house cages. In the closed house cage, the zone opposite the inlet (zone 2) results in a temperature rise, a rise in ammonia levels, a drop in humidity, a loss in body weight, and an increase in mortality.

Keywords: Broilers, Closed house, Microclimate conditions, Performance and Zoning.

INTRODUCTION

Since broilers are a breed of chicken native to subtropical regions, Indonesian climate conditions must be suitable for them. Originating from sub-tropical regions, broilers are a kind of chicken that needs the right microclimate to be raised in Indonesia. Central Sulawesi is one of the provinces in Indonesia which is located close to the equator. This causes the climatic conditions to be different from those of other regions. The ambient temperature in the Central Sulawesi area is a maximum of 32-35°C and a minimum temperature of 27-28°C. The average relative humidity during the day is 65–82% and 87–98% at night (Alfiandy et al., 2020). Environmental conditions (microclimate) are one of the factors that affect the productivity of broilers. An environment's microclimate includes factors like wind speed, humidity, and temperature of the air (Saputra et al., 2015). Microclimate conditions in the cage can be regulated with the use of closed-house cages.

It is essential to employ closed-house cages to reduce environmental conditions. A closed house has several benefits: it can accommodate a larger number of hens; it provides more protection against external factors like weather, disease, and physical disturbances; it also reduces pollution and improves breed homogeneity. The ability to control environmental conditions and manage cage maintenance is made possible by the closed-house system's application of advanced technology.

System enclosure closed house has the principle of providing good air conditions and minimizing contact with humans to affect livestock productivity (Suasta et al., 2019). There are distinct climate zones within closed-house cages. Zoned in the closed house is the colling pad area, which is cooler than the exhaust fans in the surrounding regions (Renata et al., 2018). The division of zones serves to facilitate the control and maintenance of broilers (Jaya et al., 2022).

Zoning inside the house has different temperatures, humidity, wind speeds, and ammonia levels. An increase in temperature in the house will contribute to ammonia levels, and air humidity, and thus affect broiler performance. Saputra et al. (2020) show that the increase in relative humidity (RH) and wind speed are closely related to temperature, Heat Index (HI), and wind speed. Environmental conditions inside and outside the house can adversely affect the condition and productivity of broilers.

Central Sulawesi is an area close to the equator. This causes the climatic conditions to be different from those of other regions. The ambient temperature in the Central Sulawesi area is a maximum of 32-35°C and a minimum temperature of 27-28°C. The average relative humidity during the day is 65–82% and 87–98% at night (Alfiandy et al., 2020).

RESEARCH METHODS

This research was carried out in a closed-house cage “Chicken Farm Janna”, in Taipa Village, North Palu District, Palu City, Central Sulawesi Province. This research will be carried out from June 9, 2023 – July 6, 2023. The livestock used are broilers aged 1-28 days with DOC weights (Day-old chick) ± 40 grams/head. The strain of chickens used is Lohman produced by PT. Japfa Comfeed Indonesia.

A complete feed (Table 1) with code SB-10, SB-11, and SB-12 was given during maintenance as a starter, grower dan finisher rations.

Table 1. Nutritional Content of Broiler Rations

Content	SB-10 1-14 days	SB-11 14-21 days	SB-12 21 day-harvest
Water	Max 12%	Max 12%	Max 12%
rude Protein	Min 22,5%	Max 21%	Min 19%
Crude Fat	3-7%	3-7%	3-8%
Crude Fiber	Max 5%	Max 5%	Max 5%
Ash	Max 7%	Max 7%	Max 7%
Calcium	0,9-1,1%	0,9-1,1%	0,9-1,1%
Phosphor	0,6-0,9%	0,6-0,9%	0,6-0,9%

The study used a closed house with a length of 120 meters, width of 12 meters, height of 2 meters, and capacity of 20,000 heads. The house is divided into 2 zones, each zone measuring 60 meters long, 12 meters wide, and 2 meters high. The litter of the cage uses rice husks. The cage equipment is 810 Automated Feeders, 1,700 nipples, 600 Baby Chick Feeders, 3 hoppers, 7 exhaust fans Size 50" and 1 Temptron 607. Temptron uses age-based temperature regulation to automatically adjust the cage's temperature for the broiler. This tool has sensors for humidity and temperature.

The equipment used in this study is Castrel to measure temperature, humidity, and wind speed, hydrion AM 40 Ammonia Test Paper to measure ammonia levels digital scales to weigh chicken body weight, and wooden bulkheads to separate chickens between zones.

This study used a t-test with 2 treatments, and 9 repeats (18 experimental units). The treatment with two different cage zones is:

Z1: Zone 1-60 meters from inlet

Z2: Zone 60-120 meters from inlet

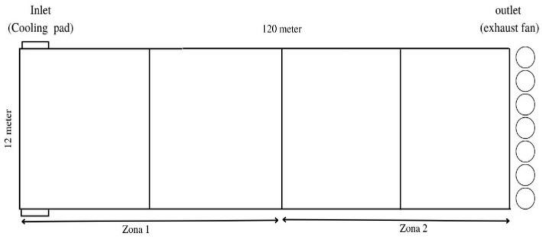

Figure 1. Zoning in Cages

Temperature and Humidity

Temperature and humidity and wind speed measurements are carried out using *Kestrel 3000* (Hamiyanti, et al., 2023). Temperature and humidity were measured every day at 12.00 WITA and 00.00 WITA.

Ammonia Content

A micro-essential lab AM40 hydrion ammonia meter test paper was used to measure the ammonia levels in the air in terms of parts per million (Glover, et al., 018). Measurements are carried out every week (Hamiyanti, et al., 2023). The test paper was held for fifteen seconds, one to two inches above the cage floor's center. There were distinct color changes at 0, 10, 20, 50, and 100 parts per million (ppm) to represent the ammonia level (Creamer, et al., 2014).

Body Weight

Body weight sampling was carried out as much as 2% of the population randomly. The body weight of the broiler sample is calculated by dividing the weight of the weighed (kg) by the number of chickens weighed.

Mortality

The mortality rate (%) is calculated using the formula by Jimmoh, et al. (2022).

Heat Stress Index (HIS)

The heat stress index was calculated using the formula (Ustomo, 2016) as follows:

Heat Stress Index = Temperature (°F) + %RH
= {9/5 x temperature (°C) + 32} + % RH

Data Analysis

The data obtained are analyzed statistically following the design used Analysis of the t-Test with the following formula:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Information:
$\bar{X}$ = Average zone 1
= Average zone 2$\bar{Y}$
s = Standard deviation of Zones1 and 2
n = Number of samples

RESULTS AND DISCUSSION

Effects of Different Zoning on Temperature

Table 2 shows that temperatures in zone 2 are higher-than in zone 1.

The results of the statistical analysis of the t-test showed that different zoning had a significant effect (t count > t table) on the temperature in the closed house enclosure. The temperature will increase as the inlet distance increases. This is because in zone 1 there is a cooling pad or evaporative system so that it can reduce the temperature that enters the cage. The ventilation system in the closed house cage has an inlet near the cooling pad and receives clean air then supplied into the cage (Dewanti et al., 2014). The cooling pad and exhaust fan can be adjusted through the temptron so that the temperature inside the cage can be made according to the conditions of the chickens.

Table 2. Average Temperature at Different Zoning in Closed House Cages.

Week	Zone 1 (°C)	Zone 2 (°C)
1	33,5	34,0
2	30,7	31,5
3	30,4	31,1
4	29,4	30,1

The average air temperature in the closed house in week 1 was higher than in weeks 2 to 4 (Table 2). This is because the first and second weeks are in the brooding period which requires a heater. The brooding period is maintenance when DOC (day-old chick) is up to 14 days or until the heater is no longer used (Fatmaningsih et al., 2016). The use of heaters will affect the air temperature in the cage so that there is an increase in temperature. The temperature inside the house is not only influenced by ambient temperature but also by the temperature of the heater/brooder and the chicken's body heat, which is the result of metabolism (Hamiyanty et al, 2023)

Effects of Different Zoning on Humidity

Table 3 shows that humidity in Zoning 1 is higher compared to Zone 2. The results of the statistical analysis of the t-test showed that different zoning had a real effect (t count > t table) on the humidity in the closed house.

The humidity level was lower as the inlet distance increased (Arnandha, 2019). This is due to the presence of Evaporative Systems which can increase the concentration of water vapor in the air. Evaporating the system will affect the humidity that carries air particles with a temperature of 20°C so that they are scattered inside a closed house. In zone 2 the humidity level decreases due to increased air temperature. Increased air temperature in the cage will decrease air humidity (Suherman et al., 2017). This is because high air temperatures will break down water vapor in the air so that humidity becomes lower. In addition, air humidity can also be influenced by other factors including wind speed (Puspani et al., 2018).

Table 3. Average Humidity in Different Zoning in Closed House Cages.

Week	Zone 1 (%)	Zone 2 (%)
1	72,9	71,7
2	73,1	73
3	73,0	70,1
4	76,9	75,3

Effects of Different Zoning on Ammonia Levels

Table 4 shows that ammonia levels in Zoning 2 are higher compared to Zone 1. The results of the statistical analysis of the t-test showed that different zoning had a significant effect (t count > t table) on the ammonia content of the air in the closed house cage.

Table 4. Average Ammonia Levels in Different Zoning in Closed House Cages

Week	Zone 1 (ppm)	Zone 2 (ppm)
1	0	0
2	4,0	8,3
3	5,7	10,7
4	8,2	14,5

The ammonia content in this study is lower than the study conducted by Jaya et al (2022), ammonia levels in Zone 1 are 17 ppm and in Zone 2 are 18 ppm.

Zuprizal (2009) said ammonia levels of 15-20 ppm are still relatively safe for broiler health.

The temperature in zone 2 is higher compared to zone 1. Increased ammonia levels are caused by differences in temperature and humidity in the cage. An increase in temperature will cause chickens to consume a lot of water, liquid excreta, and moist litter. Moist litter will cause increased ammonia levels. This is also reinforced by Metasari et al., (2012) who stated that wet litter faster spurs the fermentation process and increases NH3 production. The nitrogen content (N) in broiler manure is the basic component of ammonia, the more it is, the more it is converted to ammonia (NH3). Maliselo and Nkonde (2015) stated that the microclimatic level of ammonia is influenced by the nitrogen content in excreta.

The Effect of Different Zoning on the Body Weight of Broilers

Table 5 shows that the body weight of broilers in Zoning 1 is higher compared to Zone 2.

Table 5. Average Body Wight of Broiler in Different Zoning in Closed House Cages.

Week	Zone 1 (grams/head)	Zone 2 (grams/head)
1	178	174
2	450	431
3	830	790
4	1365	1335

The results of the statistical analysis of the t-test showed that different zoning had a significant effect (t count >t table) on the body weight of broilers in *closed-house cages*. The body weight of broilers with a maintenance age of 28 days in this study was 1,365 grams/head in Zone 1 and 1,335 grams in Zone 2. The body weight of broilers in this study did not meet the standard body weight of 28 days old, which is 1,615 grams/head. This is due to differences in temperature, humidity, ammonia levels, and feed consumption at different inlet distances. In accordance with Nurhidayat et al (2020), broiler body weight in the zone close to the inlet is higher.

The air quality and temperature are more comfortable for the chickens living close to the inlet. Microclimate temperature conditions in Zone 2 were higher than in Zone 1 (Table 2). High temperatures will cause broilers to attempt to expel body heat with pantin*g*. In addition, chickens getting excess heat will increase the heat stress index which has an impact on animal feed consumption so that body weight is low. Broiler chickens that experience heat stress will reduce feed intake by 8% and increase feed conversion by 25% (Fatis et al., 2021). This condition will reduce broiler feed consumption so that its growth is not optimal. Cumulative feed consumption in this study was 1,805 grams/head. Feed consumption in this study is still below the standard feed consumption of broilers at the age of 28 days, which is 2,209 grams (Cobb., 2018). Different microclimate conditions cause feed consumption to decrease and weight gain is not optimal. In addition, an increase in microclimatic ammonia in areas away from the inlet can reduce livestock body weight.

An increase in microclimatic ammonia in areas away from the inlet can reduce livestock body weight. Ammonia levels in different zones, namely 4.0 ppm – 14.5 ppm, can affect the body weight of broilers in *closed-house* cages. This is to research conducted by Hidayat *et al* (2020), zones that move away from the inlet have a real effect on reducing broiler body weight. Broiler body weight can decrease by up to 8% due to ammonia exposure in livestock aged 0-4 weeks (Milles *et al*., 2004 in Jannah., 2020). Exposure to ammonia will have an impact on respiratory tract damage so that ration consumption is low and body weight decreases. Respiratory tract disorders decreased the productivity of chickens and swelling *of the bursa Fabricius*

(Rachmawati, 2000). Respiratory disorders have an impact on decreasing metabolic rate caused by decreased oxygen binding. This has the potential to occur in zones that move away from the inlet so that body weight is lower.

Effects of Different Zoning on Mortality

Mortality in this study was 1.37% and 1.78% (Table 6). The percentage of mortality rate is still within the normal range according to the opinion of Sumarno et al (2022), the percentage of mortality during the broiler rearing period is a maximum of 4%.

Table 6. Average Mortality of Broiler in Different Zoning in Closed *House Cages.*

Week	Zone 1		Zone 2	
	Head	(%)	Head	(%)
1	36	0,36	43	0,43
2	15	0,15	15	0,15
3	55	0,55	79	0,79
4	31	0,31	41	0,41

This is influenced by the use of closed-house cages. The use of closed-house cages has a real influence on broiler mortality (Suasta et al., 2019). In addition, maintenance management on the research enclosure is well maintained.

Broiler mortality in Zone 2 is higher than in Zone 1 (Table 4-6). This is due to rising temperatures and ammonia accumulation in zone 2. Mortality in areas far from the inlet is due to heat accumulation, air quality, and ammonia levels (Daryatmo, 2021). Younis *et al* (2016) that increasing temperatures can increase ammonia volatilization and ammonia emissions. Increased air temperature will cause chickens to experience heat stress. Heat stress conditions will result in mortality because broilers cannot compensate for body temperature with environmental temperature.

The Effect of Different Zoning on the Heat Stress Index.

Table 7 shows that the heat stress index in zone 1 is higher compared to zone 2. The results of the statistical analysis of the t-test showed that different zoning had a significant effect (t count > t table) on the heat index stress in closed-house cages.

The Effect of Different Zoning on the Heat Stress Index

Table 7 shows that the heat stress index in zone 1 is higher compared to zone 2. The results of the statistical analysis of the t-test showed that different zoning had a significant effect (t count > t table) on the heat index stress in closed-house cages.

Table 7. Average Heat Stress Index of Broilers in Different Zoning in Closed House Cages

Week	Zone 1	Zone 2
1	165,3	164,8
2	160,3	161,6
3	159,7	158,0
4	161,8	161,5

The heat stress index zone away from the inlet has a lower heat stress index value (Table 7). A heat stress index that exceeds the tolerance limit of broilers will cause heat stress. The heat stress index that can still be tolerated by broilers is 160, 155 for DOC (day-old chick), and 140 for broilers aged 35 days. Heat stress is a condition caused by broilers not getting optimal environmental conditions. This is due to the influence of temperature and humidity. If the temperature is too hot or too cold it can cause stress and decreased productivity.

Air temperature and humidity can increase Index Heat stress. Based on this study, the average humidity, temperature, and humidity in Zone 1 are 31.0 °C and 73.9%, and in Zone 2 are 31.6 °C and 72.5%. The level of dampness in Zone 1 is higher so the heat stress index higher than in Zone 2. This condition is supported by a combination of ambient temperature and humidity that exceeds the Heat Stress Index. Hidayat et al (2020) state that the heat stress index in zones far from the inlet will decrease by 0.54%. The main factor in the improvement heat stress index is moisture. Humidity is a major part of the heat stress index (Palupi, R., 2015). When the humidity in the coop is high, the chicken's respiratory system has to work extra to remove its body heat. Hot and humid pens will make it difficult for livestock to balance body heat (panting) (Woro et al., 2019).

Broilers who experience heat stress will show behavior to widen the body surface and will breathe through the throat (Putra *et al*., 2018). Macroclimate and microclimate conditions in unsuitable pens will cause livestock stress and have an impact on decreasing production (Utama et al., 2021).

CONCLUSION

In the closed house cage, the zone opposite the inlet (zone 2) results in a temperature rise, a rise in ammonia levels, a drop in humidity, a high body weight, and an increase in mortality.

SUGGESTION

Based on the results of the research obtained, the researcher suggests:

1. The cage should be kept at a comfortable temperature during the day by using heat absorbers or insulators.
2. Control airflow and density to protect animals from heat stress.

To provide broilers with the ideal temperature for growth, environmental conditions within the cage are better managed.

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