

The Effect of Closed House Density Near the Outlet on the Production of Carcass, Non-carcass, and Abdominal Fat of Finisher Broilers

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Abstract. The purpose of this study was to investigate the closed house cage density near the outlet that affected the production of carcass, non-carcass, and abdominal fat of finisher phase broilers and to ascertain the number of closed house cage density that could produce the ideal amount of carcass, non-carcass, and low abdominal fat. The experiment employed a completely randomized design with four treatments: T0 (10 birds per square meter), T1 (12 birds per square meter), T2 (14 birds per square meter), and T3 (16 birds per square meter). It was replicated five times using different number of broilers in each replication depending on the cage density. The observed variables were live weight, carcass weight, percentage of carcass, percentage of non-carcass, and percentage of abdominal fat. Data were subjected to analysis of variance and further tested with Duncan's multiple-range test. The study was carried out for 35 days at Farm H. Noto Miharjo in Adiwarno Village, Buayan District, Kebumen Regency, Central Java. The research results showed that the live weight, carcass weight, and carcass percentage were significantly impacted by closed house cage density at the area near the outlet, although non-carcass percentage and abdominal fat were not significantly impacted. A closed house cage density of 12 birds per square meter at the area near the outlet can provide an optimal production of carcass, non-carcass, and abdominal fat.

Keywords: Closed house, outlet, broilers, carcass, non-carcass, abdominal fat

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh kepadatan kandang closed house pada zona dekat outlet terhadap produksi karkas, non karkas, dan lemak abdominal broiler fase finisher serta mengetahui berapa jumlah kepadatan kandang closed house pada zona dekat outlet yang mampu menghasilkan produksi karkas dan non karkas optimal serta lemak abdominal yang rendah. Rancangan yang digunakan adalah Rancangan Acak Lengkap, terdiri atas empat perlakuan yaitu T0 (kepadatan kandang 10 ekor per m²), T1 (kepadatan kandang 12 ekor per m²), T2 (kepadatan kandang 14 ekor per m²), dan T3 (kepadatan kandang 16 ekor per m²). Setiap perlakuan diulang sebanyak lima kali, dan setiap ulangan terdiri atas jumlah boiler yang berbeda sesuai kepadatan kandang yang digunakan. Peubah yang diamati yaitu bobot hidup, bobot karkas, persentase karkas, persentase non karkas, dan persentase lemak abdominal. Data dianalisis dengan sidik ragam, dan diuji lanjut dengan uji wilayah berganda Duncan. Penelitian dilaksanakan selama 35 hari di Farm H. Noto Miharjo yang berlokasi di Desa Adiwarno, Kecamatan Buayan, Kabupaten Kebumen, Jawa Tengah. Hasil penelitian menunjukkan bahwa kepadatan kandang closed house pada zona dekat outlet berpengaruh nyata terhadap bobot hidup, bobot karkas, dan persentase karkas, namun berpengaruh tidak nyata terhadap persentase non karkas dan lemak abdominal. Kepadatan kandang closed house pada zona dekat outlet sebanyak 12 ekor per m² dapat menghasilkan produksi karkas, non karkas, dan lemak abdominal yang optimal.

Kata kunci: Closed house, outlet, broiler, karkas, non karkas, lemak abdominal

Introduction

At the dawn of Indonesia's economic recovery in 2021 and the increasing public revenue, the need for broiler meat and all materials related to the poultry sector seem to grow. This increasing demand for broiler

products boosts poultry development, particularly broiler farming. The maintenance interval for broilers is 35 days; therefore, starting a business in the broiler maintenance sector is an appealing, prospective option.

Broiler livestock business generally has two housing systems: open-house system and

closed-house system. Selecting a cage system depends on the available resources and the environment in which the cage will be constructed. In a closed cage system, the microclimate may be changed, designed, and managed to maintain broilers in their comfort zone, whereas the microelements in an open cage system depend on the surrounding natural conditions (Hameed et al., 2012; Muharlién et al., 2020).

The closed-house system is divided into zones. Zone 1 is an area at a distance of 0 m from the inlet, zone 2 is the 1/4 length of the cage, zone 3 is the 1/2 the length of the cage, and zone 4 is the 3/4 the length of the cage (Brilianto et al., 2019). Zone 1 is close to the cooling pad and has a lower temperature than Zone 4, which is adjacent to the exhaust fan and receives the stored heat from Zone 1 to Zone 4. This results in temperature and humidity fluctuations that affect the ammonia levels and broilers' performance (Renata et al., 2018). Differences in temperature, humidity, and ammonia levels in closed-house cages caused by air entering from the inlet carries heat to the outlet, and thus temperature at the outlet is accumulated and is assumed to affect litter conditions (Diyantoro et al., 2018). Differences in ammonia levels contribute to unequal body weight that may not be as uniform as intended (Widjaya et al., 2022; Zuowei et al., 2011), resulting in suboptimal carcass weight.

In general, each closed house cage zone has the same broiler density to adjust the size of the cage although Zone 4 has a higher temperature, and higher ammonia levels (heat stress), thus producing smaller body weight compared to the closer zone to the inlet. Accordingly, a variation in density is needed in each of these zones.

Every cage area contains different numbers of broilers to modify the broiler density in each zone to produce various ammonia levels in each zone. A proper level of density is crucial for the

production of best carcasses and the least amount of abdominal fat in broilers. Excessive stocking densities may have a detrimental effect on the finisher phase broilers when the body weight per unit area ratio is at its highest. According to Yani et al. (2014) a closed cage system can accommodate 12 to 16 birds per square meter. Under certain conditions, such as stocking density levels that are too high, broiler holders will harvest earlier on 22 to 24 days.

The level of cage density and chicken growth are tightly correlated (Fausiah et al., 2020). Cage density is a crucial factor in broiler production due to its effects on health, welfare, behavior, and performance. High density causes high ambient temperature and humidity which can result in heat stress (Abudabos et al., 2013). According to Ayoola et al. (2014); Nasr et al. (2021); and Thema et al. (2022), stocking density negatively impacts the health and welfare of chickens because it restricts their mobility. Further negative impact on broiler sector is the hampered growth of broilers, which in turn causes declining economic growth.

Decreasing the growth rate will result in a lower final weight and carcass weight, while the carcass is part of the body that determines broiler production. According to Nasr et al. (2017) and Shakeri and Le (2022) heat stress might become one of the worst things that can happen to the chicken sector because it significantly reduces meat production, which is an essential component of the broiler industry's economic success.

The goal of this study was to determine the effect of closed-house cage density at the area near the outlet on the live weight, carcass weight, and the percentages of carcass, non-carcass, and abdominal fat of finisher phase broilers and to determine how many closed house cage density at the area near the outlet were able to produce for an ideal production of carcass, non-carcass, and abdominal fat.

Materials and Methods

Materials

The average broiler body weight in this study was 1,001 g/bird, with a 2.5% variation coefficient, and based on MB of 202 unsexed broilers aged 22 days, so a total of 260 finisher phase broilers. The ration used was the commercial SB 12 ration. The nutritional content of the commercial ration is presented in Table 1, while the treatment feed in Table 2 followed the standard of Ardana (2017).

Research Methods

The cage area used for this research was located near the outlet or near the fan, measuring 9 m long and 3 m wide. The partition between each of the 20 cage plots was 1x1m, made of wire and supported by wood. Treatments and replications were utilized to plot

the number of broilers in each cage. The cage plots were equipped with a stretch of rice husk about 5 cm thick, and each plot had one feeder and one drinker.

At the age of 22 days, a total of 260 broilers ($\pm 1,000$ g each) were randomly selected from the main cage to be weighed and placed into various cage plots in accordance with the treatment and replication. The rations were given once in the morning at 8:00 AM, then the leftover rations were collected from each plot at 7:00 AM the following day to be weighed. Water drinking containers were cleaned twice daily, in the morning and in the evening. The cage plots were not cleaned but every three days new husks were introduced, and any clumped-up litter was removed. At the age of 35 days, the broilers were collected, weighed, and recorded for their final weight.

Table 1. Nutritional content of SB 12 commercial rations

Nutrition Content	Finisher (SB 12)
Water Level (%)	7
Ash (%)	7
Crude Protein (%)	19
Crude Fat (%)	5
Crude Fiber (%)	5
Calcium (%)	0.8 -1.1
Phosphor (%)	0,50
Phytase Enzyme	>400 μ FTU/kg
Amino Acid	
- Lysin (%)	1.05
- Methionin (%)	0.40
- Methionin-systin (%)	0.75
- Trypthofan (%)	0.18
- Theonin (%)	0.65
Metabolism Energy	2900 Kcal/kg

Source: Product Packaging Labels of PT. Japfa Comfeed Indonesia

Table 2. Standard broiler ration needs age 1-35 days

Age (Day)	Maintenance (gram/head/day)	Portion (gram/head/day)
1-7	17	18.70
8-14	43	47.30
15-21	66	72.60
22-28	91	100.10
29-35	111	122.10

Source: Ardana (2017)

Experimental Design and Statistical Analysis

Four treatments and five replications were used in the experiment using a completely randomized design. Different numbers of broilers were employed for each treatment according to the cage density. The data were examined using an analysis of variance (ANOVA) and in case of significant effect at 5% level, Duncan's multiple range test would be applied. The treatments consisted of:

- T0: 10 birds/m²
- T1: 12 birds/m²
- T2: 14 birds/m²
- T3: 16 birds/m²

The research parameters observed include:

1. Live weight (g), obtained from the result of weighing the chicken after being fasted for 6 hours.
2. Carcass weight (g), obtained from the result of weighing chicken without blood, feathers, head to base of neck, legs up to the knees, and internal organs.
3. Carcass percentage (%), obtained from dividing the carcass weight (g) by live weight (g), then multiplied by 100%.
4. Non-carcass percentage (%), the internal organs observed were the gizzard, liver, and heart. Each internal organ's weight (g) was divided by the live weight (g), then multiplied by 100%.
5. Abdominal fat percentage (%), was calculated from dividing the weight of abdominal fat (g)

by the carcass weight (g), then multiplied by 100%.

6. Ammonia levels (ppm), ammonia meter was used to measure ammonia levels at 06.30 AM, at 00.30 PM, and at 7.30 PM.

Results dan Discussion

Live Weight

The average live weight of broilers in each treatment (Table 3), from lowest to the highest was T2 (1,746 g), T3 (1,790 g), T0 (1,908 g), and T1 (1,941 g). The results of the ANOVA showed that cage density at the area near the outlet had a significant effect ($P < 0.05$) on the live weight of the broilers. Duncan's multiple range test showed that T0 and T1 were not significantly different ($P > 0.05$), T2 and T3 were not significantly different ($P > 0.05$), but T1 was significantly different ($P < 0.05$) from T2 and T3. It demonstrates that the higher the cage density at the area near the outlet, the lower the live weight of the broilers.

Previous research by Widjaya et al. (2022) showed that the increasing density of cage at the area near the outlet can reduce daily body weight gain, and results in decreasing broiler live weight. This is presumably due to impaired absorption of nutrients in the intestinal mucosa of broilers because of incomplete metabolic processes that result from a lack of oxygen levels entering the broiler's body caused by increased ammonia levels due to the high density of cages.

Table 3. Average of Live Weight, Carcass Weight, Carcass Percentage, Gizzard Percentage, Liver Percentage, Heart Percentage, and Abdominal Fat Percentage for Each Treatment During the Study

Observed Variables	Treatments			
	T0	T1	T2	T3
Live Weight (g)	1,908±46.04 ^{ab}	1,941±112.10 ^a	1,746±143.41 ^c	1,790±97.72 ^{bc}
Carcass Weight (g)	1,311±46.02 ^a	1,348±56.52 ^a	1,150±101.49 ^b	1,165±78.82 ^b
Carcass Percentage (%)	68.71±1.45 ^a	69.51±1.55 ^a	65.84±1.02 ^b	65.05±1.23 ^b
Gizzard Percentage (%)	1.94±0.18	1.95±0.14	1.93±0.09	2.03±0.22
Liver Percentage (%)	2.10±0.05	1.96±0.17	1.85±0.22	1.91±0.33
Heart Percentage (%)	0.63±0.21	0.71±0.24	0.45±0.13	0.50±0.11
Abdominal Fat Percentage (%)	0.73±0.20	0.92±0.27	0.79±0.33	0.77±0.33

Note: Different superscript letters indicate significantly different ($p < 0.05$)

The ideal temperature for a relative growth rate of broiler live weight at the finisher phase is 20-24°C (Herawati and Adiwianto, 2012). The ambient temperature in the zone near the outlet in this study ranged from 26.17°C to 29.82°C. A higher ambient temperature that exceeds the heat released from the body can cause heat stress in poultry, thus resulting in decreased daily body weight gain followed by lower live weight. According to Lara and Rostagno (2013), heat stress is the result of a negative balance between the amount of net energy released by the body of livestock to the environment and the amount of heat energy produced by livestock. This imbalance can be caused by variations in combined environmental factors (sunlight, thermal irradiation, temperature, humidity, and wind speed) and livestock characteristics (species, metabolic rate, and thermoregulatory mechanisms).

Carcass Weight

Body weight after removing the gastrointestinal tract, blood, head, skin, and all four legs, starting from the joint of the carpus and tarsus downward, is known as the carcass weight. Carcass weight and carcass percentage are two methods to express carcasses as a unit of production (Nurlia et al., 2020). The average carcass weights in each treatment during the study (Table 3) from the lowest to the highest were T2 (1,150 g), T3 (1,165 g), T0 (1,311 g), dan T1 (1,348 g). The highest carcass weight was obtained at a cage density of 12 birds/m². The results of the ANOVA showed that cage density at the area near the outlet had a significant effect ($P < 0.05$) on broiler carcass weight. Duncan's multiple range test showed that T0 and T1 were not significantly different ($P > 0.05$), T2 and T3 were not significantly different ($P > 0.05$), but T0 and T1 were significantly different from T2 and T3 ($P < 0.05$). It shows that the higher the cage density at the area near the outlet, the lower the carcass weight of the broilers. Similarly, broiler live weight decreases with the

increase of cage density near the outlet. Carcass weight is affected by live weight, so high live weight equals high carcass weight, and vice versa. This is in accordance with Wahju (2004) that high carcass weight is supported by the final live weight as a result of higher live weight.

The overly dense population of broilers in T2 and T3 triggered stress in broilers and affected their growth. According to Haroen (2003), a decrease in growth rate will lead to lower body weight. Carcass weight gain is closely related to live weight and body weight gain, so low live weight will produce low carcass weight because the main carcass components are bones and muscles. According to Barruni et al., (2020) cage density can affect body weight uniformity. When the cage is too dense, chickens cannot feed and drink simultaneously. This non-uniformity can lead to dominating behavior in many chickens. Young et al (2001) stated that the main factors of carcass production are strain, sex, age, health, nutrition, live weight, and fasting before slaughter.

Carcass Percentage

The average percentage of broiler carcass in each treatment (Table 3) from the lowest to the highest. The data in Table 3 showed that the average percentage of the carcass from the lowest to the highest were T3 (65.05%), T2 (65.84%), T0 (68.71%), and T1 (69.51%). The lowest average percentage of carcass weight was found in T3 with a cage density of 16 birds/m², and the highest in T1 with a cage density of 12 birds/m². The results of the ANOVA showed that cage density at the area near the outlet had a significant effect ($P < 0.05$) on reducing the percentage of broiler carcasses. Duncan's multiple range test showed that T0 and T1 were not significantly different ($P > 0.05$), T2 and T3 were not significantly different ($P > 0.05$), but T0 and T1 were significantly different from T2 and T3 ($P < 0.05$), meaning that the cage density of 14 birds/m² and 16 birds/m² could reduce the percentage of broiler carcass.

The percentage of carcass produced in this study for 35 days ranged from 65.05% to 69.51%, lower than the results of the study by Samsi and Sulistiyawan (2022) who reported a carcass percentage of 73.78%-75.98% 34-day-old Cobb strain broilers and 73.30%-74.87% for 34-day-old Ross strain broilers. Based on research data, a decrease in carcass percentage is influenced by an increase in the closed-house cage population in the area around the outlet. The decreased carcass percentage is related to the decrease in the broiler's daily body weight. Widjaya et al., (2022) reported that daily body weight decreased at T2 (cage density of 14 birds/m²) and T3 (cage density of 16 birds/m²). It is due to a higher population of broilers in T2 and T3 than in T0 and T1, which produced more excreta and made the litter moist. According to Pereira (2017), moist litter is an optimal condition for bacteria to convert uric acid into ammonia, thus increasing ammonia levels in the litter.

Increased ammonia levels in T2 and T3 can irritate the respiratory tract, resulting in subpar oxygen levels entering the body. This has an impact on metabolism, specifically by preventing nutrients from being absorbed by the intestinal mucosa of broilers. This reduces daily body weight gain and lowers the proportion of carcass weight (Widjaya et al., 2022). Increased ammonia levels can also cause oxidative stress. According to Puspitasari et al., (2019), oxidative stress is a condition due to an imbalance between the body's antioxidant defense system and the production of free radicals. The results of increased oxidative stress are decreased productivity, stunted growth rates, decreased feed consumption, and increased mortality.

The ammonia concentrations in T0 and T1 were 5 ppm, while in T2 and T3 were 16.5 ppm. Although the ammonia concentrations in T2 and T3 are still below the threshold that can be tolerated by broilers, which is 25 ppm (Al-Homidan et al., 2003), it can reduce oxygen binding capacity and have an impact on decreasing metabolic rate, this causes the

metabolic energy to decrease. Wahyu (2015) states that the function of metabolic energy is for the synthesis of body components and the growth of every body tissue.

Increased ammonia levels can also cause heat stress in broilers, the temperature in the cage rises due to the heat generated by broilers in the metabolic process. The heat released is relatively low when compared to the heat received by the broiler. According to Qurniawan et al. (2016), the heat produced by a chicken's metabolism and heat from the surroundings combines to create the temperature inside the cage. The high air temperature surrounding broilers will make them experience heat stress and lose energy because the energy that should be utilized to increase body weight in the broiler is instead used to regulate internal heat.

Gizzard, Liver, and Heart Percentage

The average percentages of the gizzard, liver, and heart in each treatment (Table 3) from the lowest to the highest were T2 (1.93%), T0 (1.94%), T1 (1.95), and T3 (2.03). The average percentage of liver from the lowest to the highest were T2 (1.85%), T3 (1.91%), T1 (1.96%), and T0 (2.10%). The data in Table 3 also showed the average percentage of heart from the lowest to the highest were T2 (0.45%), T3 (0.50), T0 (0.63%), and T1 (0.71%).

The results of ANOVA showed that the treatments had no significant effect ($P > 0.05$) on the percentage of gizzard, liver, and heart, meaning that differences in cage density were not able to significantly change the production of the gizzard, liver, and heart. According to Setiadi et al., (2013), live weight affects giblet weight. The greater the live weight, the giblet weight will increase. In fact, the weight of the giblet is assumedly influenced by the nutritional content of the ration, especially the crude fiber content.

In this study, the normal function of the gizzard was probably because the crude fiber was within the normal range. The crude fiber content in the research feed was 5% or within

the normal range suggested by SNI (2015) namely 5-6%. It was in accordance with Setiadi et al., (2013) that crude fiber content that does not exceed 6% is within the tolerance limits for poultry. Additionally, heat stress results in decreased consumption, which means low consumption of crude fiber and no extra work for the gizzard to remain normal. According to Saputra et al., (2015), one of the contributing factors to gizzard weight is crude fiber in feed; the higher the crude fiber ratio, the higher the gizzard activity and the greater the weight.

This study observed that the liver could also work normally and the rations did not contain toxic substances that could interfere with liver function. One of the functions of the liver is to detoxify toxic compounds in the broiler's body. Liver functions according to Jumiati et al., (2017) include exchanging substances from protein, fat, bile secretion, detoxification of toxic compounds, and excreting useless metabolite compounds.

The function of the heart organ is to circulate blood throughout the body and into the lungs to replace O₂ and CO₂ to support body metabolism (Jumiati et al., 2017). The research feed did not contain anti-nutritional or toxic substances, so it did not cause excessive contractions in the heart muscle. Suryanah et al., (2016) reported that rations that do not contain toxins or anti-nutritional substances do not cause heart defects in broiler chickens.

Based on the study results, it is evident that the differences in closed-house cage density at the area near the outlet do not affect the gizzard weight of the broilers. It is in line with Barruni et al., (2020) that different densities in closed-house cages did not significantly affect the gizzard weight of broilers at 28 days.

Abdominal Fat Percentage

The data in Table 3 showed that the average percentage of abdominal fat from the lowest to the highest was T0 (0.73%), T3 (0.77%), T2 (0.79%), and T1 (0.92). The lowest average

percentage of abdominal fat weight was found in T0 (10 birds/m²) and the highest was in T1 (12 birds/m²). The results of ANOVA showed that treatments had no significant effect ($P>0.05$) on the percentage of abdominal fat, meaning that differences in cage density were not able to significantly change the percentage of abdominal fat.

Abdominal fat in this study was within the normal range of 0.73-0.92%. According to Pratikno (2011), fat tissue begins to form quickly at the age of 6-7 weeks, and from there, the accumulation of fat continues to accelerate, especially abdominal fat at the age of 8 weeks. It is likely because the broilers in this study were still 35 days old, whereas the rapid accumulation of abdominal fat occurred after 42 days of age.

Fatty conditions tend to be good if the percentage of abdominal fat is lower, thus improving carcass quality. Abdominal fat is a byproduct that affects carcass quality. According to Fajrih and Khoiruddin (2020), carcass quality is affected by the by-products of abdominal fat; therefore, the smaller the percentage of abdominal fat produced, the better the resulting carcass.

Based on the study results, we could see that the optimal carcass percentage of broilers aged 35 days was obtained at a cage density of 12 birds/m². This is in line with the study results of Mardewi et al., (2019) and Subagia et al., (2019) which recommended a cage density of 12 birds/m² in the maintenance broilers aged 5 weeks because they can produce optimal carcass weight and carcass percentage without reducing meat quality.

Conclusion

Closed house cage density in the area near the outlet impacted carcass production but not the production of non-carcass and abdominal fat. A cage density of 12 birds/m² in the area near the outlet can result in optimal carcass, non-carcass, and abdominal fat production.

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