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The Effect of Wind Chill in Closed House on Broiler Performance

Pengaruh Wind Chill pada Closed House terhadap Performa Ayam Broiler

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ABSTRACT

Fan settings (wind speed) in the cage must be adjusted to the age and weight of the chickens. Any movement of the wind at a certain speed will have an impact on the difference between the actual temperature read on the thermometer and the effective temperature felt by the chickens. This is because there is a cold temperature effect (wind chill effect) due to air movement. On the 1st floor of the KTM cage, there was an error setting the fan on which caused the wind speed to be higher than necessary, causing a wind chill effect. This case caused the performance of the chickens in the 1st-floor cage not to reach the target. To get the ideal temperature and wind speed in the cage, the effort needed is to adjust the fan to turn on taking into account the wind chill effect. Based on the results of considering the wind chill effect in the cage, the value of feed intake, body weight gain, and body weight at the age of 7-35 days appear to be higher with a low feed conversion value and a higher production index.

Keywords: Broiler, Closed House, Production Performance, Wind Chill

ABSTRAK

Pengaturan kipas (kecepatan angin) di dalam kandang harus disesuaikan dengan umur dan berat ayam. Setiap pergerakan angin pada kecepatan tertentu akan memberikan dampak terhadap perbedaan antara suhu aktual yang dibaca pada termometer dengan suhu efektif yang dirasakan ayam. Hal ini karena ada efek suhu dingin (*wind chill effect*) akibat adanya pergerakan udara. Pada kandang KTM lantai 1 terjadi kesalahan setingan kipas menyala yang menyebabkan kecepatan angin lebih tinggi dari yang diperlukan sehingga menimbulkan wind chill effect. Kasus ini menyebabkan performa ayam pada kandang lantai 1 tidak mencapai target. Untuk mendapatkan suhu dan kecepatan angin yang ideal pada kandang maka upaya yang diperlukan yaitu mengatur kipas yang menyala dengan mempertimbangkan adanya wind chill effect. Berdasarkan hasil pertimbangan wind chill effect di dalam kandang nilai konsumsi pakan, pertambahan bobot badan dan bobot badan pada umur 7-35 hari terlihat lebih tinggi dengan nilai konversi pakan yang rendah serta capaian indeks produksi yang lebih tinggi.

Kata Kunci: Broiler, Closed House, Performa Produksi, Wind Chill

INTRODUCTION

Broiler chickens are a source of animal protein needed by the community, therefore the supply of animal protein must be increased in line with the increasing of population. One source of animal protein obtained from livestock is broiler chicken. The broiler is a superior breed of chicken resulting from crosses from chicken breeds that have high productivity, especially in producing meat. Based on the results of the 2017 Staple Food Consumption Survey (SFCS) and the 2019 National Socioeconomic Survey (NSN) conducted by BPS RI, consumption of broiler meat was 12.79 kg/capita/year. To fulfill the need for animal protein food for the people of Indonesia, the government has made efforts to increase production results sourced from livestock businesses, including broiler chickens or broilers. Broiler meat production in 2020 will reach 3.275.325.72 tonnes (BPS RI 2021).

Housing factors play a very important role in chicken farming. This is because the coop is the place where chickens live from the initial age until they are harvested. Several farms in Indonesia have started using the closed house type in building cage construction. This closed cage system has advantages including being able to create an ideal environment by removing excess heat, excess moisture, harmful gases (CO, CO_2, and NH_3) in the cage, more controlled cages, increasing chicken productivity, efficiency land and labor, and more environmentally friendly. Errors in operating a closed house can be fatal which can lead to losses for farmers (Prihandanu 2015). To achieve uniformity and good growth of chickens, controlling the temperature in the closed house must be done from the start, namely during the brooding (starter) period. Success in this brooding period will be followed by the next period, making it easier for breeders to obtain optimal profits. Failure in the brooding period will cause productivity to decrease, this is because the genetic potential of chickens cannot be achieved optimally (Fadilah 2013). The ideal temperature for the coop must be evenly distributed so that all the chickens can grow properly. The ideal temperature of the cage can be achieved with the appropriate wind speed value. On the other hand, the wind speed in the coop can provide a wind chill effect so that the temperature felt by the chickens is lower than the measured ambient temperature, so it is necessary to adjust the fan to produce the appropriate wind speed (Fadilah 2013).

One of the factors that can affect the temperature in the cage is wind speed. The effective temperature shows the comfort level of broiler chickens because the effective temperature describes the temperature that is actually felt while in the cage. The wind speed setting in the coop must be adjusted to the age and weight of the chickens. Any movement of the wind at a certain speed will have an impact on the difference between the actual temperature read on the thermometer and the effective temperature felt by the chickens. This happens because there is a wind chill effect due to air movement. The higher the wind speed, the higher the wind chill effect. There are many cases of production failure in closed houses because they do not take into account the impact of the wind chill effect on chickens. As a result, chickens grow late, not uniform, and fail to form the immune system (Fadilah 2013). Based on this description, it is necessary to study the effect of the wind chill effect or inappropriate cage temperature settings in KTM cages on feed intake, body weight gain, body weight gain, depletion, feed conversion ratio, and production index during broiler maintenance.

MATERIALS AND METHODS

This research was carried out in the stables of KTM (Kronreif & Trunkenpolz Mattighofen) which is a customer of PT. New Hope Indonesia is engaged in raising broiler chickens using a closed-house system. The KTM stable is located in the Walantaka area, Serang City, Banten. The KTM stable building has 2 floors with a length of 105 meters and a width of 12 meters with a height of 2 meters for each floor with a population of 22,000 birds on each floor. The method used is a case study. Data collection was carried out using a survey method, namely by visiting the location directly, doing practice, observing, interviewing, and analyzing the conditions of the case study site. Primary data was obtained through in-depth direct interviews to obtain the necessary basic data with breeders, technical service of PT. New Hope Indonesia, the head of the stable, and other cage employees were used as respondents. Secondary data in this study were obtained through intermediaries or parties who had collected the data.

Thermoneutral Zone (Temperature Requirement)

The thermoneutral zone is a condition in which the range of environmental temperatures according to the needs of chickens is affected by the heat generated by broiler chickens during rearing. The thermoneutral zone will change depending on several factors, namely body weight, ventilation (air movement), feed intake, and relative humidity. Broiler chickens can achieve optimal growth if kept in the thermoneutral zone. The thermoneutral zone can be determined by calculating the following formula:

$$\text{TNZ (°C)} = 31{,}896 - (4{,}625 \times \text{Body Weight (kg)})$$

Wind Chill Effect

The main problem in cultivating broiler chickens with a closed cage system will arise if it is not able to synergize the wind speed with the temperature according to the needs of the chickens and humidity. The temperature needs of the chickens are met, but the wind speed and humidity are not suitable, it will have a bad impact on the chickens because their comfort of the chickens is disturbed. The wind speed setting in the coop must be adjusted to the age and weight of the chickens. Any movement of the wind at a certain speed will have an impact on the difference between the actual temperature read on the thermometer and the effective temperature felt by the chickens.. The wind chill effect based on age and wind speed is presented in Table 1. The effective temperature when operating the cage can be calculated using the following formula:

$$\textit{Effective Temperature} = \textit{Actual Temperature} - \textit{Wind Chill Effect}$$

Feed Intake (FI)

Feed Intake or cumulative feed consumption is obtained by adding up feed consumption on the first day of rearing to the last day of rearing or harvesting.

Body Weight (BW)

The growth of broiler chickens is very dependent on the feed given, if the feed is given in sufficient quantities and contains good and appropriate nutrition then broiler chickens can reach standard weights at each age. (Marom *et al*. 2019). The average body weight of broiler chickens can be calculated based on the following formula:

$$\textit{BW} = \textit{Weighing Weight (kg)} / \textit{Number of Chickens}$$

Feed Conversion Ratio (FCR)

The feed conversion ratio is the amount of feed weight given to produce one kg of broiler live weight. The FCR value indicates the efficiency of absorption of feed nutrients. The smaller the feed conversion value, the more

Table 1. Wind chill effect based on age and wind speed

Wind Speed (ft/min)	Wind Speed (m/s)	4-7 (week)		Dewasa	
		F (young)	C (young)	F (old)	C (old)
50	0.25	0.5	0.3		
100	0.51	0.8	0.5	0.3	0.2
150	0.76	4.3	2.4	1.5	0.8
200	1.02	6.5	3.6	2.3	1.3
250	1.27	8	4.4	4	2.2
300	1.53	8.3	4.6	5	2.8
350	1.78	9	5	5.5	3
400	2.03	10	5.6	6	3.3
450	2.29	10.5	5.8	6.5	3.6
500	2.54	10.5	5.8	7	3.9

Source: Fadilah (2021)

efficient the broiler is in converting the feed into better meat. The FCR calculation uses the following formula:

$$FCR = \frac{Feed\ Intake\ (kg)}{Harvest\ Weight\ (kg)}$$

Depletion

Depletion is depreciation of chickens, either due to death or rejection. To calculate the percentage of depletion, the following formula is used:

$$Depletion\ (\%) = \frac{Initial\ Population\ -\ Harvest\ Population}{Initial\ Population} \times 100\%$$

Production Index (IP)

Production index is a formula that is commonly used to assess the performance of broiler chickens. The greater the value of the production index obtained, the better the performance of the chickens and the more efficient use of feed. The production index value indicates the success of the chicken production process which is affected by mortality, FCR, body weight, and harvesting age. The production index value is obtained using the following formula:

$$FCR = \frac{(100 - \%\ Depletion) \times Average\ Body\ Weight\ (kg)}{FCR \times\ Harvest\ Age\ of\ Chicken} \times 100$$

Statistical Analysis

Analysis of production performance using Microsoft Excel 2021. Broiler production performance can be assessed from feed intake, body weight, body weight gain, feed conversion ratio (FCR), depletion, and production index.

RESULTS AND DISCUSSION

Fan Operation at the 1st Floor KTM Cage

The principle of regulating the operation of the fan is how to adjust the wind speed in the coop to be adjusted to the temperature required by the chickens, to meet the minimum air requirements needed by the chickens, and to pay attention to the effect of cold air (wind chill effect). Thermoneutral zone (TNZ), effective temperature, wind chill effect, and wind speed based on actual body weight in the KTM cage are presented in Table 2.

Based on Table 2, the effective temperature felt by the chickens in the 1st-floor cage is lower when compared to the temperature required by the chickens. This is due to an error in setting the fan on which does not take into account the wind chill effect due to air movement which can cause chickens to tend to get cold. During the brooding period, chicks have not been able to adapt to environmental temperatures, and their body heat regulation systems have not functioned optimally because feather growth has not been perfect (Mukminah and Puwarsih 2019). Broiler chickens that experience cold will result in stunted growth. If during the brooding period (0-21 days) the growth is stunted, then the target weight achieved will also be below the standard. Likewise, the consumption of broiler chicken feed does not reach the desired feed consumption standard, which results in the achievement of a very low (less) production index

Table 2. TNZ, effective temperature, wind chill effect, and wind speed based on actual body weight in the 1st-floor KTM cage

Age (Day)	Body Weight (kg)	Actual Temperature (°C)	TNZ (°C)	Effective Temperature (°C)	WE (°C)	Wind Speed (m/s)
7	0.196	31.1	30.9	30.6	0.5	0.51
14	0.455	30.9	29.8	27.3	3.6	1.02
21	0.830	30.7	28.0	26.3	4.4	1.53
28	1.299	30.1	25.9	24.3	5.8	2.29
35	1.750	30.4	23.8	24.6	5.8	2.54

TNZ = Thermoneutral Zone; WE = Wind Chill Effect

Table 3. TNZ, effective temperature, WE and wind speed based on standard weight on the KTM cage

Age (Day)	Body Weight (kg)	TNZ (°C)	Effective Temperature (°C)	WE (°C)	Wind Speed (m/s)
7	0.186	31.0	31.0	0.1	0.25
14	0.465	29.7	29.7	1.2	0.51
21	0.943	27.5	27.5	3.2	1.02
28	1.524	24.8	24.8	5.3	1.78
35	2.191	21.7	21.7	8.7	2.54

TNZ = Thermoneutralzone; WE = Wind Chill Effect

value during the harvest period. Any movement of air at certain speed results in the difference between the actual temperature read on the thermometer and the effective temperature felt by the chicken. The higher the wind speed, the higher the wind chill effect will be and will have an impact on the effective temperature felt by the chickens which are lower than the required temperature. Standard required temperature requirements (Thermoneutral Zone), effective temperature, wind chill effect, and wind speed based on standard body weight in KTM cages are presented in Table 3.

Effect of Wind Chill on Feed Intake, Body Weight Gain, Body Weight, and Feed Conversion Ratio (FCR)

Feed Intake (feed consumption) is the amount of feed consumed by chickens in a certain period. Feed consumption will increase every week according to the increase in the body weight of the chickens. Based on Table 4, it can be seen that the actual feed consumption of chickens at the age of 14 to 35 days is lower when compared to the standard feed consumption in KTM cages. This is because, during the rearing process, the chickens do not get the desired temperature. Chickens in the coop get low temperatures due to high wind speeds which cause a wind chill effect due to air movement so that the temperature felt by the chickens tends to be cold. In addition, the wind chill effect will appear if there are holes in the brooding that can provide air access and directly affect the chickens. During cold weather, a stream of cool, moist air tends to quickly fall to the coop floor (replacing warm air on the floor) causing chickens to shiver. Because the cold air stream has little ability to absorb moisture from the litter, there will be increased ammonia formation and litter clumping. This incident will cause respiratory disorders which will increase cases of respiratory disease in chickens so that the appetite of chickens also decreases and causes stress in chickens. Actions that can be taken for this problem are by adjusting the fan that turns on based on the wind chill effect and closing the gaps in the brooding area (using a blocking layer) so that the temperature can be maintained. Effect of Wind Chill on Feed Intake, body weight gain, body weight, and feed conversion ratio.

The value of body weight gain in broiler chickens is presented in Table 4. Based on the table it can be seen that the body weight gain of chickens at the age of 14 to 35 days is lower when compared to the standard body weight gain of chickens in KTM cages. This slow body weight gain is caused by low feed consumption at the age of 14-35 days. This is to the report of Qurniawan (2016) that the factors that influence body weight gain are feed consumption and the environment. Uzer *et al*. (2013) also reported that body weight gain is closely related to feeding, in terms of quantity related to feed consumption if feed consumption is disrupted it will cause slow growth so that body weight at harvest is also low.

Feed Conversion Ratio is the ratio between the amount of feed consumed and the total weight of broiler chickens produced. The smaller the FCR value, the better. FCR values in cages on the 1st floor are presented in Table 4. Based on the table it can be seen that the FCR of chickens at the age of 35 (harvest) days is higher when compared to the standard FCR in the KTM cage. This high FCR value is caused by poor feed consumption, and slow body weight gain when the chickens are 14-35 days old. An FCR value that is below the standard means that cultivation requires a smaller amount of feed than the standard consumption to produce 1 kg of broiler meat. Conversely, if the FCR value

Table 4. Value of feed intake, body weight gain, body weight and feed conversion ratio

Age (Day)	WE (°C)	Feed Intake (gram)		Body Weight Gain (gram)		Body Weight (kg)		FCR	
		(Actual)	(Standard)	(Actual)	(Standard)	(Actual)	(Standard)	(Actual)	(Standard)
7	0.5	169	167	28	26.4	0.196	0.186	0.86	0.89
14	3.6	527	542	32.5	33.2	0.455	0.465	1.15	1.16
21	4.4	1006	1192	39.5	44.9	0.830	0.943	1.21	1.26
28	5.8	1781	2137	46.4	54.4	1.299	1.524	1.37	1.4
35	5.8	2892	3352	50	62.6	1.750	2.191	1.65	1.53

WE = Wind Chill Effect; FCR = Feed Conversion Ratio

is above the standard, it means that cultivation requires more feed than the standard consumption to produce 1 kg of broiler meat.

Effect of Wind Chill on the percentage of Depletion and Production Index

Depletion is the rate of death and culling (separation or termination of chickens) in rearing during one production which is usually calculated as a percentage, while the Production Index is a formula that is commonly used to determine the performance of broiler chickens. The greater the IP value obtained, the better the performance of the chickens and the more efficient use of feed. The percentage of depletion and production index in the first-floor cages are presented in Table 5. Based on the value of feed consumption, body weight gain, body weight, and feed conversion in Table 4 it shows that the chickens did not reach the target at the age of 14-35 days so it had an impact on achieving a high depletion value at harvest age which was 3.43% or more than the standard (2%) and also had an impact on the achievement of a very low production index value during the harvest, which was 299.

Table 5. Depletion value and production index on the 1st-floor KTM cage

Age (Day)	Depletion (%)	Production Index
7	0.70	323
14	1.18	277
21	2.01	320
28	2.86	329
35	3.43	292

Ideal Temperature and Wind Speed Requirements for KTM Cage Floor 1

Not fulfilling the needs of ideal temperature and wind speed in the cage will have an impact on feed consumption that does not reach the target resulting in slow body weight growth (disruption of hyperplasia and hypertrophy processes), high FCR, high depletion, and acquisition of a very high production index value. low (less). This is supported by the statement (Fadilah 2013) that production failure in closed houses due to not considering the wind chill effect will cause slow, non-uniform chicken growth and failure to form the chicken immune system. To get the ideal temperature and wind speed in the coop, the effort needed is to adjust the fan or wind speed which must be adjusted to the body weight of the chicken, the desired temperature and to adjust the fan which is into taking account the wind chill effect. The steps taken when setting the temperature of the coop so that the required temperature for the chickens can be met are as follows.

Example: It is known that the chicken is 14 days old with an average body weight of 0.455 kg, requiring an ideal temperature of 29.8°C. After observing the fan capacity, the wind speed is known. If the wind speed of 2 fans is known to be 1.02 m/s, then the wind chill effect can be seen in the table at (3.6°C). Then the 2 fans turn on at a temperature = 29.8 + 3.6 = 33.4 °C. Likewise, the application is to chickens aged 21, 28, and 35 days.

Recommendations for setting the temperature in the first-floor cage with consideration of body weight and the wind chill effect to get an effective temperature according to the needs of the chickens are presented in Table 6.

Comparison Results Consideration of Wind Chill Effect

Based on Table 7, taking into account the wind chill effect, it can be seen that feed consumption and body weight are higher when compared to without considering the wind chill effect. The low gain in body weight gain in the cage on the 1st floor is suspected because the chickens did not get the desired body temperature while in the cage or an error in the temperature setting resulting in decreased feed consumption. The increase in body weight is in line with the increase in feed consumption, the higher the feed consumption, the higher the body weight, because one of the functions of feed in the chicken's body is not only for basic life needs but also for growth. Sufiriyanto *et al*. (2020) stated that the function of feed in the chicken body is to meet basic needs, from body tissue cells, to replace damaged parts, as well as to production needs.

Taking into account the wind chill effect, the feed conversion at the age of 35 days is also lower than without considering the wind chill effect. The lower the feed conversion rate, the better. According to (Nuryati 2019), the feed conversion value is not only influenced by the density of the cage, the weight of each individual, and age but it can also be affected by the temperature in the cage. Pakage *et al*. (2018) also stated that an uncomfortable ambient temperature could affect feed conversion. Fadilah (2021) also reported that setting the wind speed in the coop must be adjusted to the body weight and temperature needed by the chickens so that they can meet the minimum air requirements needed by the chickens by paying attention to the wind chill effect.

Table 6. Recommendations for temperature regulation on the 1st-floor KTM cage with consideration of the wind chill effect

Age (Day)	Body Weight(kg)	Actual Temperature (°C)	TNZ (°C)	Effective Temperature (°C)	Wind Speed (m/s)	WE (°C)	Setting Temperature (°C)
7	0.196	31.1	30.9	30.6	0.51	0.5	31.1
14	0.455	30.9	29.8	27.3	1.02	3.6	33.4
21	0.830	30.7	28	26.3	1.53	4.4	32.4
28	1.299	30.1	25.9	24.3	2.29	5.8	31.7
35	1.750	30.4	23.8	24.6	2.54	5.8	29.6

Table 7. Feed intake, body weight gain, body weight, and FCR with consideration of the wind chill effect

Age (Day)	Feed Intake (gram)		Body Weight Gain (gram)		Body Weight (kg)		FCR	
	1st floor*	2nd Floor**	1st floor*	2nd Floor**	1st floor*	2nd Floor**	1st floor*	2nd Floor**
7	169	176	28	28.4	0.196	0.199	0.86	0.88
14	527	560	32.5	34.3	0.455	0.480	1.15	1.16
21	1006	1123	39.5	45.5	0.830	0.955	1.21	1.26
28	1781	1976	46.4	53.2	1.299	1.490	1.37	1.40
35	2892	3121	50	54.9	1.750	1.920	1.65	1.53

FCR = Feed Conversion Ratio;* = Without consideration of the wind chill effect; ** = With consideration of the wind chill effect

Table 8. Depletion and production index by considering the wind chill effect

Age (Day)	Depletioin (%)		Production Index	
	1st floor*	2nd Floor**	1st floor*	2nd Floor**
7	0.70	1.28	323	317
14	1.18	1.82	277	289
21	2.01	2.89	320	376
28	2.86	5.18	329	380
35	3.43	6.64	292	315

* = Without consideration of the wind chill effect; ** = With consideration of the wind chill effect

Based on the data in Table 8, taking into account the wind chill effect seen in chickens aged 35 days (harvest period) shows a higher production index (sufficient) when compared to before considering the wind chill effect (less). The greater the IP value obtained, the better the performance of the chickens and the more efficient use of feed. The IP value indicates the success of the chicken production process which is affected by mortality, FCR, body weight, and harvesting age (Fadilah *et al*. 2013). Santoso and Sudaryani (2009) stated that the standard production index values were <300 (poor), 301-325 (enough), 326-350 (good), 351-400 (very good), and >400 (excellent).

The high percentage of depletion on the 2nd floor of the coop was due to a large number of rejected chickens. The large number of rejected chickens in the 2nd-floor cage was due to the fact that the chickens in the cage were not uniform (experiencing slow growth). This was due to late selection or culling during chick-in and during the first week of rearing. If the chicken selection activities are not optimal, it will cause competition between small chickens and big chickens in the cage when eating and drinking and will trigger the emergence of cannibalism in large chickens. Culling is the separation or rejection of chickens that are seen externally (outside/physically) and are assessed for their potential which may affect production/performance. While the selection is choosing good and productive individuals from a group of chickens, then the selected chickens must be bred. Chickens that look small or whose body weight does not reach the standard during the rearing process are still being selected because if not selected it will only affect the high FCR value which will cause losses to the breeder. Culling can be done at the time of initial maintenance, the growth period, and before the production period. Because making early and timely observations can prevent unwanted events in the future. Selection and culling can also be done when data recording shows that the feed conversion ratio (FCR) level far exceeds the standard. Ramadhani (2016) reported that one of the factors that cause high depletion rates in a stable is maintenance management.

CONCLUSION

Fan settings (wind speed) and temperature settings in closed houses without considering the wind chill effect cause low feed consumption levels, slow growth, and result in low body weight and high FCR values at harvest. Based on the results of considering the wind chill effect in the cage, feed consumption, and body weight gain, body weight at the age of 7-35 days appear to be higher with a low feed conversion value when compared to without consideration of the wind chill effect. The production index value taking into account the wind chill effect was seen in chickens aged 35 days (harvest period) showing a higher value (enough) when compared to without considering the wind chill effect (less).

REFERENCES

BPS (Badan Pusat Statistik). 2019. Survei sosial ekonomi nasional (SUSENAS) 2017. Badan Pusat Statistka.

BPS (Badan Pusat Statistik). 2021. Konsumsi bahan pokok 2019. Badan Pusat Statistka. Jakarta (ID).

Fadilah, R. 2013. Beternak ayam broiler. Agro Media Pustaka. Bogor (ID).

Fadilah, R. 2021. Basic sciences "manajemen pengoperasian closed house". PT. New Hope Indonesia. Banten (ID).

Marom, A. T., U. Kalsum, & U. Ali. 2017. Evaluasi

performans broiler pada sistem kandang close house dan open house dengan altitude berbeda. Dinamika Rekasatwa. 2(2):1-10.

Mukminah, N & R. Purwasih. 2019. Profitabilitas usaha peternakan ayam broiler dengan tipe kandang yang berbeda. Jurnal Ilmiah dan Teknologi Rekayasa. 2(1):8-13.

Murti, A. T., K. S. Suroto & H. Karamina. 2020. Broiler pola mandiri di kabupaten malang (studikasus di kecamatan karangploso kabupaten malang). Jurnal Sosial Ekonomi Pertanian. 14(1):40

Nuryati, T. 2019. analisis performans ayam broiler pada kandang tertutup dan kandang terbuka. Jurnal Peternakan Nusantara. 5(2):77-86.

Pakage, S., B. Hartono., Z. Fanani., B. A. Nugroho, & D. A. Iyai. 2018. Analysis of cost structureand income of broiler chicken farming business by using closed house system and open house system. Jurnal Peternakan Indonesia. 20(3):193-200

Prihandanu, R., A. Trisanto, & Y. Yuniati. 2015. Model sistem kandang ayam closed house otomatis menggunakan omron sysmac CPM1A 20-CDR-A-V1. Jurnal Rekayasa dan Teknologi Elektro. 9(2): 60-81.

Qurniawan, A. 2016. Kualitas daging dan performa ayam broiler di kandang terbuka pada ketinggian tempat pemeliharaan yang berbeda di kabupaten takalar sulawesi selatan. Tesis. Program Pascasarjana, Institut Pertanian Bogor. Bogor.

Ramadhani, R. A. 2016. Korelasi antara tingkat deplesi terhadap bobot panen, pertambahan bobot badan, konsumsi pakan, dan feed conversion rasio pada ayam pedaging. Thesis. Fakultas Peternakan Universitas Brawijaya. Malang.

Santoso, H & T. Sudaryani. 2009. Pembesaran ayam pedaging di kandang panggung terbuka. Penebar Swadaya. Jakarta.

Sufiriyanto., N. Hidayat., D. Indrasanti., A. P. Nugroho, & Harwanto. 2020. Evaluasi produktivitas ayam niaga pedaging kandang closed house dan open house di eksperimental farm. Prosiding Seminar Teknologi dan Agribisnis Peternakan VII Webinar: Prospek Peternakan di Era Normal Baru Pasca Pandemi COVID-19, Fakultas Peternakan Universitas Jenderal Soedirman, 27 Juni 2020, ISBN: 978-60254.

Uzer, F.N., Iriyanti, & Roesdiyanto. 2013. Penggunaan pakan fungsional dalam ransum terhadap konsumsi pakan dan pertambahan bobot badan ayam broiler. Jurnal Ilmiah Peternakan. 1(1): 282-288.