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Full Length Research Paper

Assessing the Impact of Housing System, Placement Time, and Feed Withdrawal on Broiler Performance and Wellbeing.

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The purpose of this study was to evaluate the effects of the housing system, feed withdrawal, and placement time on broiler development and performance. Six hundred-day-old Cobb-500 broiler chicks were used in this study. This study used slatted floors and deep-litter housings. In the morning, 300 birds were placed in the pens, while another 300 birds were placed in the afternoon. A feeding schedule was implemented for half of the birds from 11:30 am to 4:30 pm, whereas the other half was fed ad libitum. The experiment had eight treatments; each replicated thrice using a 2 × 2 × 2 factorial design. Each replicate consisted of twenty-five birds. The average total feed consumption was significantly higher (P < 0.001) on slatted floors than on the deep litter. Moreover, the average final body weight, weekly weight gain, and feed conversion ratio of broilers in slatted floor housing were higher (P < 0.001) than those in deep litter. The slatted housing group had a significantly higher water intake (P < 0.001). Nevertheless, the experimental factors had little effect on the death rate. Although the feeding and placement times did not affect the overall performance, the slatted floor housing system produced better results.

Keywords: Deep litter housing, Slatted floor housing, body weight, feed intake, Feed Withdrawal, growth, Placement time

INTRODUCTION

The success of the world and Ghana in broiler production has been hampered by several issues. The main obstacles are the cost and accessibility of feed and feed ingredients, quality of day-old chicks, competition from frozen meat imports, use of birds with low genetic potential, and pests and diseases (Anang et al., 2013). Inadequate management and unsuitable housing have caused enormous financial losses in the poultry industry. Housing issues and management appear to be disregarded, although most of the difficulties in broiler production have drawn significant attention from specialists (Kusi et al., 2015). Birds housed in cages recorded (P ≤0.05) higher values for live body weight (LBW) and body weight gain (BWG) than birds housed in a floor system at 35 days of age (El-Deen et al., 2020). Inadequate housing or lack thereof may negatively affect the productivity and well-being of birds. A house's interior climate is crucial for maintaining birds' best health, growth, and productivity. This is where housing design has come into play. According to Ketelaars and Gietema (2001), the type of housing used on a chicken farm is typically determined by the local conditions in the area. Housing has a significant impact on animal welfare and performance (Wei et al., 2019). Gizzard development was unaffected by floor design, whereas fully slatted flooring caused larger body weights (Abd El-Wahab Amr et al., 2020). Inappropriate housing could expose birds to predators and dangers of the weather, restrict free movement against basic animal welfare rules, and affect their performance (Fortomaris et al., 2007).

In Ghana, open-sided deep-litter dwellings are the most widely used type of housing. Although deep-litter housing is less expensive to build overall, Oloyo (2018) noted that

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it quickly accumulates heat, which can lead to welfare diseases such as footpad dermatitis. Proper and consistent management skills are required to achieve maximum production.

As a result, deep litter places a higher demand on labor. In addition to deep litter, battery cages, when built correctly, have been proven to enhance production and facilitate litter management. However, it is expensive, causes more breast blisters, does not provide birds with adequate room to roam around, and is not the best option for broiler chickens raised in tropical climates. Hence, it is the largest housing system that violates many welfare regulations for birds and has been banned in some parts of the world (Sogunle et al. 2008).

When broilers are fed ad libitum, they may feed up to three times their maintenance requirements. This may make broilers vulnerable to various metabolic disorders, such as sudden death syndrome (SDS) (Kalmar et al., 2013), and deposit more abdominal fat, which is not preferred by consumers (Mushtaq et al., 2014). The ability of birds to withstand heat stress may be due to much easier regulation of the anticipated rise in their body temperature due to the cessation of further heat production during that crucial period. Feeding management to deny broiler feed during the hottest hours of the day may help reduce heat stress in birds (Mahmood et al., 2005).

According to Abdullah (2014), a decrease in the weight of live broilers is positively correlated with the length of feed withdrawal times, demonstrating that feed withdrawal times result in higher live broiler shrinkage. When broilers are removed from the feed for at least six hours, their body tissues shed moisture and nutrients, resulting in weight loss that may reduce edible production (Northcutt et al., 2010). The fast-growing modern lines are more dependent on proper environmental conditions (Farghly et al., 2018) than birds from lines raised years ago.

Placement time is defined as the time delay at the hatchery after pulling, rather than the time spent during transportation to the farm, a period during which chicks are denied feed (Obun and Osaguona 2013). Early exposure to food has been linked to better performance in chicks in the future, but a study has found that while the body weight (BW) of chicks fasting post-hatching is lower than that of others at the first notch, this effect does not persist towards the end of the production phase (Bergoug et al., 2013). Considering the information above, this study aimed to compare the effects of two housing systems, feed withdrawal versus ad libitum, and different placement times of chicks on production performance.

MATERIALS AND METHODS

Experimental site

This research was carried out at the Poultry Research Center of Kwame Nkrumah University of Science and Technology in Kumasi. Located in a moist semi-deciduous forest, Kumasi experiences a range of temperatures, with January being the coldest month and having an average low temperature of 20.4°C, and February being the hottest month with an average high temperature of 33.5°C. The amount of rainfall in Kumasi varies greatly, with January having the lowest amount (15.1%) and June having the highest (214.3 mm). The coordinates for Kumasi are latitude 060 41"N and longitude 010 33"W, and it is situated at an elevation of 261 meters above sea level, with temperatures ranging from 230 to 31 degrees Celsius (Ackerson and Awuah, 2012).

Experimental design

Six hundred (n=600) Cobb500 broiler day-old chicks were bought from a commercial hatchery; upon arrival, half (300) were put in pens at 10 am (150 each pen), while the other half (300) were put in pens at 2 pm (150 per pen). These placement times were then tallied (PT). Until 2:00 p.m., the afternoon group was left in boxes without food or water. Two housing arrangements—a deep litter housing system (DLHS) and a slatted floor arrangement were used for each group of these chicks. The slated floor housing measured (304.8cm91.44cm60.96cm) and had approximately 3cm between slats, whereas the deep litter housing sized 304.8cm91.44cm60.96cm and had wood shaving scattered on the floor at an average thickness of 1.5cm. Brown paper sheets were placed on the slatted floor housing during the brooding period to prevent chicks from slipping and stacking between these paces.

Half of the birds in each housing system were fed ad libitum (AL), while the other half were exposed to daily feed withdrawal (FW) between 11:30 am and 4:30 pm (or during hot parts of the day) before the feed was reintroduced to the pens. The birds were exposed to light for 24 hours a day. As a result, the experimental setup resulted in a 2 x 2 x 2 factorial design with two arrival times (morning and afternoon), two feed management regimes (ad libitum versus afternoon feed withdrawal), and two housing types (deep litter versus slatted floor) arranged in completely Randomized Design (CRD) (Figure 1).

Housing types

The slatted floor housing system (SFHS) and the deep litter housing system (DLHS) were the two housing systems used in this research.

Slatted floor housing system

On a metal platform, the housing was elevated three feet

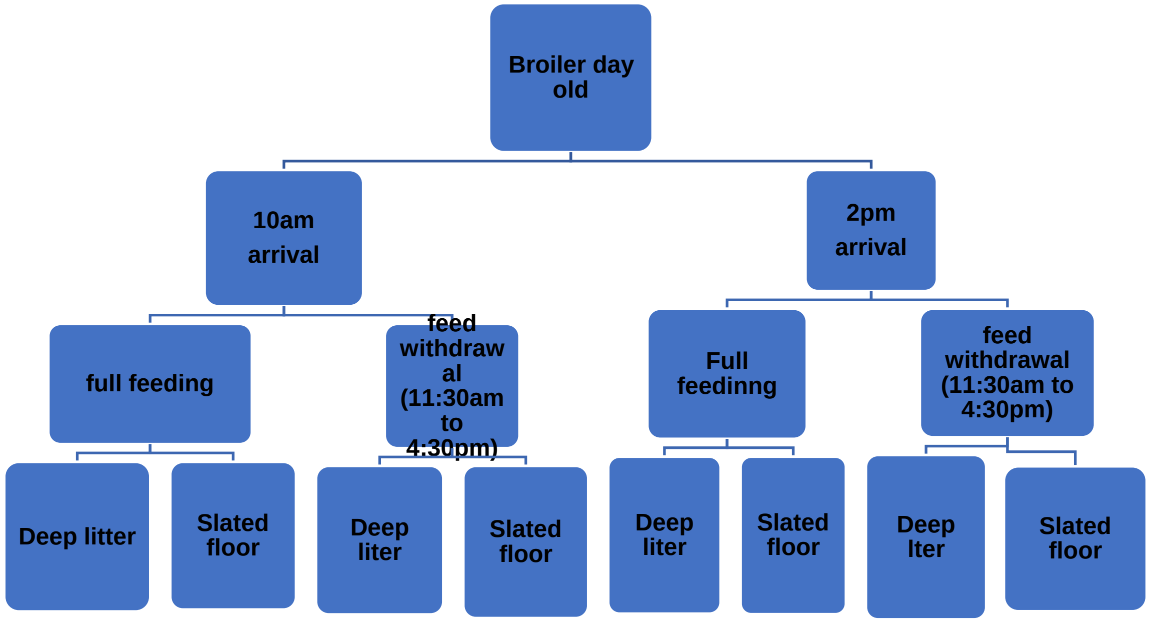

Figure 1; Experimental design, Source: Authors' construct, 2021

above the ground. To minimize the effects of light radiation and heat stress, the housing was designed with narrow sections facing sunrise and sunset because of its east-west orientation. A tiny ladder in the shape of the stairs was positioned against the door of each pen in the slatted floor housing. Wood slats were spaced 3 cm apart to allow a drop to occur beneath them.

Deep litter housing system (DLHS)

The east-west-oriented home is in its original location. Cement blocks were used to build the house to a height of approximately 60.96 cm. On the cement floor, wood shavings were scattered approximately 1.5 cm above the surface. The brooding and feeding schedules for broilers housed in this kind of housing were identical to those in the SFHS.

Experimental diet and laboratory analysis of feed samples

For a week, the birds depended on a pre-made mash. A starter/grower diet, including palm oil, was formulated and fed. Subsequently, a weeklong finisher meal was prepared and administered until the completion at seven weeks (Table 2). Throughout the trial, the body weight, water intake, and weekly feed intake were measured.
Table 1: Nutrition composition of Pre-starter diet
Table 2: Project nutrient composition of experimental diet
Table 3: Percentage composition of experimental diet

Brooding and management of birds

To protect broilers from cold stress and preserve the heat supplied by electricity, black rubbers were utilized to cover the walls of both houses during the three weeks in which the chicks were brooded. A regulated heating system utilizing a 100-watt bulb evenly distributed the heat throughout each pen. The brooding temperature was set between 30 0C and 33 0C to avoid heat exhaustion. Owing to its construction and the season of the research, the rubber in the slatted floor served as a barrier against rain in addition to aiding heat retention. The study had eight treatments, each of which was replicated three times, resulting in twenty-four replications. Each pen has a floor area of 1.2 square feet and measures 10 by 3 feet. With 25 birds for each replication, there were 75 birds per replicate. Upon arrival, the birds were weighed, and the treatments were randomly assigned. Each chick received medication and vaccination as shown in Table 4. Weekly records of feed intake and body weight were recorded for each pen.
Table 4. Vaccination and Medication chart

Performance Determinants and Variable

The amount of feed provided, and leftovers was considered to calculate the feed consumption and feed conversion ratio. The birds were weighed once a week to assess body weight and weight gain. Records were kept for each treatment, including the number of deaths, time, day, probable cause of death, and water consumption.

Statistical Analysis

The data were subjected to variance analysis using Proc. SAS 9.4 mixed procedure, $P < 0.05$ (SAS Statistical Institute Inc., 2016). Where there were differences in treatment means, Tukey's test was performed to separate them. The model included fixed effects for the

Table 1: Nutrient composition of pre-starter diet.

Parameters on as fed basis	Quantity
Crude protein (%)	22.00
Crude fat (%)	7.50
Crude fiber (%)	2.50
Lysine (%)	1.30
Methionine (%)	0.60
Meth + cyst (%)	0.95
Calcium (%)	0.95
Sodium (%)	0.2
Phosphorous (%)	0.6
Antioxidant	E321
Enzyme	4911/4954
Mold inhibitor	Added
Vitamins	Added
ME (Kcal/kg)	3150

Source: Source: Authors' construct, 2021

Table2: Proximate nutrient composition of experimental diet

Parameter on a fed basis	Grower diet (%)	Finisher diet (%)
Crude protein	22.98	24.69
Crude fat	5.67	6.1
Crude fiber	3.25	4.55
Moisture content	10.22	8.79
Ash content	6.11	8.41
NFE	54.77	47.46
ME Kcal/kg	3261.02	3073.61

Source: Authors' construct, 2021

Table3: Percentage composition of experimental diet

Ingredient	Grower diet %	Finisher diet %
Maize	55.5	59
Fishmeal	11.5	10
Soybean meal	14	15
Wheat bran	15.75	11
Oyster shell	1.8	2
Lysine	0.05	0.5
Vitamin and Minerals Premix	0.25	0.5
Dicalcium Phosphate	0.05	0.5
Palm oil	1	1
Table Salt	0.1	0.5

Source: Authors' construct, 2021

Table 4: Vaccination and Medication chart

Day (S)	Medication/Vaccination
Day 2 – Day 5	Penstrip
Day 7	Gumboro Intermediate
Day 8 – Day 10	Narcox
Day 12	Penstrip
Day 14	Newcastle HB1
Day 15 – Day 19	Antibact 3x
Day 21	Gumboro Intermediate plus
Day 22 – Day 24	Toltrazuril
Day 25 – Day 27	Penstrip
Day 29 – Day 33	Narcox
Day 34 – Day 35	Vitamins
Day 36	Lasota
Day 38	Dewormer
Day 39 – Day 43	Vitamins

Source: Authors'construct, 2021

housing system, feeding schemes, and placement time; two-way interactions for the housing system versus feeding regime, housing system versus placement time, and feeding regime versus placement; and a three-way interaction for the housing system, feeding regime, and placement time on broiler performance. The random error term was nested in a pen in which the birds were placed. The statistical model is shown in the diagram below.

Table 5: The influence of housing system, feeding systems, and placement time on feed intake of broilers

Source	Week 1 (kg)	Week 2 (kg)	Week 3 (kg)	Week 4 (kg)	Week 5 (kg)	Week 6 (kg)	Week 7 (kg)
Housing							
DLHS	0.158	0.509	0.638^{b}	0.644^{b}	0.789^{b}	1.789^{b}	1.168^{b}
SFHS	0.158	0.507	0.746^{a}	0.803^{a}	0.993^{a}	1.993^{a}	1.416^{a}
S.E.M	0.003	0.005	0.009	0.011	0.027	0.027	0.061
P value	0.8167	0.7318	<0.0001	<0.0001	<.0001	<0.0001	<0.0111
Feeding scheme							
AL	0.153^{a}	0.525^{a}	0.705	0.738	0.898	1.898	1.243
FW	0.163^{b}	0.491^{b}	0.678	0.709	0.885	1.885	1.341
S.E.M	0.003	0.005	0.009	0.011	0.027	0.027	0.061
P value	0.0074	0.0002	0.0642	0.0813	0.7452	0.7452	0.2727
Placement time							
MP	0.157	0.509	0.700	0.732	0.875	1.875	1.253
AP	0.159	0.507	0.683	0.715	0.908	1.908	1.330
S.E.M	0.003	0.005	0.009	0.011	0.027	0.027	0.061
P -value	0.4897	0.7318	0.2319	0.2900	0.4027	0.4027	0.3889

Source: Authors'construct, 2021. Means of different superscripts within a column differ significantly at P ≤ 0.05. DLHS = Deep Litter Housing System, SFHS = Slatted Floor Housing System, AL = Ad libitum, FW = Feed Withdrawal, MP = Morning placement, AP = Afternoon placement.

Table 6: The effect of the housing system, feeding system, and placement time on average water intake of broilers

Source	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Housing							
DLHS	0.46	0.96^{b}	1.50^{b}	2.03^{b}	2.47^{b}	2.98^{b}	3.08^{b}
SFHS	0.44	1.13^{a}	1.61^{a}	2.35^{a}	3.27^{a}	3.87^{a}	4.62^{a}
S.E.M	0.01	0.02	0.03	0.03	0.05	0.11	0.11
P value	0.2654	<0.0001	<0.0186	<0.0001	<0.0001	<0.0001	<0.0001
Feeding Scheme							
AL	0.45	1.00^{b}	1.56	2.21	2.88	3.39	3.86
FW	0.45	1.09^{a}	1.55	2.17	2.86	3.46	3.84
S.E.M	0.01	0.02	0.03	0.03	0.05	0.11	0.11
P value	0.5498	0.0227	0.7288	0.4436	0.7482	0.6679	0.8992
Placement Time							
MP	0.45	1.09^{a}	1.53	2.18	2.90	3.45	3.87
AP	0.45	1.00^{b}	1.58	2.19	2.84	3.40	3.84
S.E.M	0.01	0.02	0.03	0.03	0.05	0.11	0.11
P value	0.6411	0.0204	0.2313	0.8058	0.3868	0.7318	0.8645

Source: Authors'construct, 2021. Means of different superscripts within a column differ significantly at P ≤ 0.05. DLHS = Deep Litter Housing System, SFHS = Slatted Floor Housing System, AL = Ad libitum, FW = Feed Withdrawal, MP = Morning placement, AP = Afternoon placement. Water Intake = L/bird/week

$$Y_{ijkl} = \mu + A_i + B_j + C_k + 〖AB〗_{ij} + 〖AC〗_{ik} + 〖BC〗_{jk} + 〖ABC〗_{ijk} + 〖P(ABC)〗_m + \varepsilon_{ijklm}$$

Where Y is the response or performance due to the treatments given to birds, A is the fixed effect due to housing systems, B is the fixed effect due to feeding regimes, C is the fixed effect due to placement times, P is the pen effect, and ε is the residual error term.

RESULTS AND DISCUSSION

Growth Performance

The results presented in Tables 7 and 8 indicate significant differences in body weight (BW) and weight gain between broilers raised in the slatted floor housing system (SFHS) compared to those in the deep litter housing system (DLHS). Broilers in the SFHS consistently exhibited higher BW and weight gain, starting from the second week of production. This difference can be attributed to the superior hygiene and ventilation provided by the SFHS.These findings align with previous studies by Abd El-Wahab Amr et al. (2020) and Wei et al. (2019), which also found that fully slatted flooring led to larger body weights in broilers. Additionally, broilers fed ad libitum in the SFHS showed slightly higher weight gain compared to those under restricted feeding, although this did not affect final BW.Interestingly, contrary to the findings of Nijdam et al. (2005), where feed removal led to decreased final body weight, no such effect was observed in this study. Similarly, although broilers in the alternate placement (AP) treatment exhibited higher BW during week 5 compared to those in the matched placement (MP) treatment, there were no differences in final BW.Overall, broilers raised on slatted floors consistently outperformed those in deep litter systems in terms of final body weight, feed intake, average weight gain, and feed conversion ratio. This is in

Table 7: The effect of housing system, feeding regime and placement time on the overall growth performance of broilers.

Source	Chick weight (kg)	Final Body weight (kg)	Total feed intake (kg)	Average weight gain (kg)	Average FCR
Housing					
DLHS	0.043	1.865[b]	5.696[b]	1.822[b]	3.133[a]
SFHS	0.046	2.586[a]	6.615[a]	2.538[a]	2.613[b]
SEM	0.001	0.034	0.078	0.035	0.055
P value	0.198	<0.0001	<0.0001	<0.0001	<0.0001
feeding regimes					
AL	0.333	1.333	0.043	2.253	6.158
FW	0.250	1.000	0.046	2.198	6.153
SEM	0.445	1.780	0.001	0.034	0.078
P value	0.198	0.281	0.958	0.286	0.330
placement time					
MP	0.044	2.226	6.099	2.180	2.834
AP	0.045	2.225	6.212	2.180	2.911
SEM	0.001	0.034	0.078	0.035	0.055
P value	0.661	0.987	0.322	1.000	0.340

Source: Authors'construct, 2022. Means of different superscripts within a column differ significantly at P ≤ 0.05. DLHS = Deep Litter Housing System, SFHS = Slatted Floor Housing System, AL = Ad libitum, FW = Feed Withdrawal, MP = Morning placement, AP = Afternoon placement

Table 8: Effect of the housing system, feeding systems, and placement time on weekly weight gain

Source	Week1 (kg)	Week2 (kg)	Week3 (kg)	Week4 (kg)	Week5 (kg)	Week6 (kg)	Week7 (kg)
Housing							
DLHS	0.158	0.225 [b]	0.202 [b]	0.266 [b]	0.346 [b]	0.314 [b]	0.313 [b]
SFHS	0.153	0.251[a]	0.307 [a]	0.333 [a]	0.451 [a]	0.443 [a]	0.601 [a]
S.E.M	0.004	0.005	0.007	0.010	0.015	0.028	0.043
P value	0.4232	0.0041	<0.0001	<0.0003	<0.0001	<0.0051	<0.0002
Feeding scheme							
AL	0.155	0.247[a]	0.259	0.303	0.398	0.379	0.467
FW	0.156	0.229[b]	0.249	0.295	0.399	0.378	0.447
S.E.M	0.004	0.005	0.007	0.010	0.015	0.028	0.043
P value	0.8715	0.0378	0.3118	0.5798	0.9370	0.9670	0.7447
Placement time							
MP	0.153	0.237	0.250	0.302	0.372[b]	0.388	0.478
AP	0.158	0.239	0.258	0.297	0.425[a]	0.369	0.435
S.E.M	0.004	0.005	0.007	0.010	0.015	0.028	0.043
P value	0.2667	0.7505	0.4038	0.7389	0.0205	0.6498	0.4832

Source: Authors'construct, 2021. Means of different superscripts within a column differ significantly at P ≤ 0.05. DLHS = Deep Litter Housing System, SFHS =Slatted Floor Housing System, AL = Ad libitum, FW = Feed Withdrawal, MP = Morning placement, AP = Afternoon placement

line with the findings of El-Deen et al. (2020), who found that birds raised in cages exhibited better feed conversion ratios compared to floor systems. Furthermore, while there were no significant variations observed between feeding methods and placement times, birds in the SFHS showed consistently higher water intake throughout the production period. This could be attributed to improved metabolism and nutrient absorption facilitated by adequate water intake. In summary, the results suggest that the SFHS provides superior broiler production results compared to the DLHS, primarily due to better hygiene, ventilation, and potentially enhanced nutrient absorption facilitated by higher water intake.
Table 5: The influence of housing system, feeding systems, and placement time on feed intake of broilers
Table 6: The effect of housing system, feeding system, and placement time on average water intake of broilers
Table 7: The effect of the housing system, feeding systems, and placement time on the overall growth performance of broilers
Table 8: Effect of housing system, feeding schemes, and placement time on weekly weight gain

CONCLUSION

Overall, these findings underscore the importance of housing systems in broiler production, with the SFHS showing clear advantages in promoting better growth and performance compared to the DLHS. Additionally, the study suggests that factors such as feeding regimen and placement time may have less impact on broiler performance within the conditions tested.

CONFLICT OF INTEREST

Regarding the subjects covered in this work, there are no financial, personal, or other relationships that could present a conflict of interest.

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