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Original Article

Effects of brooding methods and different feed regimen on growth and development of marshal broiler chickens

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Abstract
This study was aimed at examining the effect of brooding methods and feeding regimen on the growth and development of marshal broiler chickens. Forty-eight day-old marshal broiler were used for the two phased experiment of brooding phase (heated group - H and heatless group - HL), and feed restriction phase (once daily at 8.00 hours – T1, twice daily at 8.00 and 16.00 hours – T2, and thrice daily at 8.00, 12.00 and 16.00 hours – T3). Data were collected on ambient temperature, relative humidity, mortality, feed intake, body weight gain, morphometric traits and carcass traits. General linear model and Duncan Multiple's Range Test of SPSS was used for the analysis of variation and mean separation respectively. Increased temperature and ambient relative humidity was observed in the afternoon and morning respectively throughout the brooding phase. The HL had the higher average weekly gain (AWG) within the first three weeks. Amongst the performance characteristics, only average final weight (AFW), (AWG) and average feed intake (AFI) were significantly ($P<0.05$) influenced by the feeding regimen. HL under T2 recorded the highest values (1372.66g and 734.24g) for AFW and AWG, respectively and also the best FCR (1.63). Morphometric measurements and carcass traits of birds under T2 were significantly ($P<0.05$) highest in all the parameters considered. However, HL was numerically higher than H in some parameters. It could be concluded that marshal birds raised under HL and fed twice daily at 8.00 hours and 16.00 hours can increase productivity.

INTRODUCTION

Broiler chickens have been selected over the years for their rapid growth rate, high carcass yields, and they have been reported to play an important role in the sub-sector of poultry production in Nigeria (Abe *et al*., 2022). Globally, as at 2011 and 2016, over 50 billion poultry birds and 66 billion poultry birds were produced across the world, respectively (Chatziprodromidou *et al*., 2018). However, these numbers had dropped to 23 billion birds by 2018 due to

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the outbreak of avian influenza (H5N1 and mutated strains) in China which affected 13.6% of the world's poultry supply during the year 2016 (Chatziprodromidou *et al.*, 2018). Recently, there was an increase in the demand of poultry products and this is not unconnected to the growing population and nutritional benefit of poultry meats. It has been documented that broiler production contributes positively to food provision (poultry meat), employment generation and a source of income to producers (Sogunle *et al.,* 2018). Broiler chickens being specially bred for meat production are evaluated through quality and quantity of edible parts which are expressed by dressing percentage (slaughter yields).

Marshal broilers is among the strains of broiler chicken reared by farmers in southern Nigeria. They cope fairly well with the hot season of January to March in Nigeria and reach market weight at about 7-8 weeks of age (Adetola and Simeon, 2013). To optimize production at the lowest possible cost, some of the management practices need to be done with little or no input and brooding is one of the major management practices to be given such a deep consideration. The two major stages of raising broiler chickens are brooding (starter phase) and the finisher phase. Brooding is the provision of supplemental heat and caring for the chicks to give the chicks a good start at the early developmental stage. Brooding occurs during the first 14 days of a broiler chicken's life or until the chicks are feathered and able to maintain a certain body temperature. For instance, Sogunle *et al.* (2018) reported that the usual recommended brooding temperatures of 35, 32 and 29 ^{0}C for the 1st, 2nd, and 3rd weeks, respectively could be reduced to 29, 27, and 24 ^{0}C when warm-room brooding is used. Fawwad *et al.* (2008) compared the effects of three brooding techniques (gas, electric and wood) on broiler chicken performance. They recorded significant differences in weight gain, feed consumption, feed conversion ratio, and recommended gas brooding as an economical technique to enhance the productive performance of birds. However, due to the high cost and unavailability of refined brooding equipment, alternative heat sources such as charcoal pots, kerosene lanterns and stoves have been adopted by small scale poultry producers in Nigeria Sogunle *et al.* (2018).

Feeding strategies can also be employed to reduce production cost through restricted feeding. In growing broiler chickens, feed restriction can best achieve lean carcass tissue, better feed conversion ratio (FCR) and excellent body weight gain (Gous and Cherry, 2004; Teimouri *et al*., 2005). Feed restriction will also help to prevent wastage, increase feed efficiency, reduce abdominal-fat deposition in broiler chickens and tend towards leaner carcasses (Sahraei, 2012). Previous studies have shown that feed restriction could decrease fat content and increase protein deposition in carcasses, thus resulting in the improved carcass composition (Nielsen *et al*., 2003). Ibigbami *et al.* (2021) reported that dressing percentage, liver and gizzard yields were affected by feed restriction while total feed cost was reduced with increasing severity of feed restriction from 2 to 6 weeks. Hence, restricting feed at 40% for 6 weeks is recommended based on lower abdominal fat and blood cholesterol (Ibigbami *et al.*, 2021). Hence, this study investigated the effect of brooding methods and feed restriction on performance, morphometric

and slaughter yield of marshal broiler chickens.

MATERIALS METHODS

Experimental site and animal housing

The experiment was carried out at the Poultry Unit of the Teaching and Research Farms of Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria. The farm falls within latitude 7° 28' 0" N and longitude 5°° 44 0"`` E (Google earth, 2023). The small unit cages, measuring 4ft length, 3ft breadth and 4ft height, that were used to house the birds were placed inside the farm's poultry pen house.

Management of experimental birds

A total of 48- day old marshal broiler chicks were procured from a reliable hatchery and used for the experiment which lasted for eight weeks. The birds were brooded in two groups. One group was supplied external heat and referred to as heated brooding (H) and the second group were not supplied external heat and are referred to as heatless group (HL). During brooding, big size kerosene lantern was used for the H group to supply heat and the cage was covered with white single nylon to conserve the heat within the cage, while the HL group did not have any external heat supply but the cage was covered with thick white nylon to conserve the ambient heat within the cage and were also supply with non-heating light source to remove the bias that could arise in feed intake from H group which had light source (kerosene lantern) during the night. The behavioural responses of the chicks were used as an indicator for regulating the heat within the cage for both groups. The brooding period lasted for 2 weeks after which the kerosene lantern in the H group was replaced with non-heating lamp as light source in the night. The birds were managed intensively inside the cage on a raised floor to deny access to their litters with the provision of commercial feed (starter diet), and water *ad-libitum*. All the routine management practices relevant to broiler chickens were dully observed.

Experimental design

The 48 experimental birds were divided into two groups, heated (H) and heatless (HL), with 24 chicks per group and eight chicks per replicate. The H group were supplied with external heat using kerosene lantern while the HL group were not supplied heat but the cage was covered with thick cellophane bag to conserve heat inside the cage. After the brooding phase which lasted for two weeks the birds were fed for another two weeks to measure any variations arising from heated and heatless broodings. After the fourth week the birds were subjected to restrict feeding along the line of the brooding methods. The 24 birds in each group were divided into three feeding treatments (T1, T2 and T3) with four birds per replicate. The feeding treatments are T1 which is once daily feeding (8 hour), T2 which is twice daily feeding (8 and 16 hours) and T3 which is thrice daily feeding (8, 12 and 16 hours). The birds were fed a total of 105g of feed per day. The experiment lasted for eight weeks.

Data Collection

Growth performance parameters

1. Feed intake: this was recorded weekly for each replicate. Feed left over was subtracted from the amount of feed offered to the birds weekly to determine the feed intake. Feed intake (g) = total feed offered (g) – left over feed (g). Average feed intake (g/bird) = feed intake/ number of birds

2. Body weight gain: was also recorded for each replicate. The average weight gain per

bird was noted by deducing the difference between the final body weight and initial body weight and dividing this value by the number of birds per replicate. Average body weight gain (g/bird) = (final weight (g) – initial weight (g))/number of birds

3. Feed conversion ratio (FCR): was calculated by finding the ratio of the feed intake to the body weight gain. FCR = total feed consumed (g) / body weight gain (g)

4. Mortality (%): was calculated as the ratio of the number of dead birds to the total number of birds per treatment, expressed as a percentage. % Mortality = (number of dead birds/total number of per treatment) x 100

5. Production efficiency factor (PEF) = (liveability x weight gain)/ FCR x age

Other parameters measured were morphometric traits which was done using measuring tape and these traits measured are height (H), breast length (BL), breast width (BW), shank length (SL), beak length (BKL), back length (BL) and wing length (WL).

At the end of the experiment, 4 birds per treatment (2 birds per replicate) were randomly selected for slaughter yield. Birds were deprived of feed overnight to avoid contamination during slaughtering and increase accuracy when weighing the offals. The birds were weighed and electrically stunned before slaughtering by slitting the throat. Complete bleeding was ensured and the slaughtered weight was subtracted from the live weight to get the weight of the blood. Thereafter, the feathers were removed and the carcass was weighed to get the weight of the feather by subtracting the slaughtered weight. The carcasses were weighed after removing the heads, shank, and the offals to determine the edible carcass weight. The organs like proventriculus, gizzard, liver and heart were removed from the offals and weighed.

Statistical Analysis

Data obtained were subjected to analysis of variance using general linear model of SPSS statistical package version 25 (2015). The means were separated using Duncan multiple's range test of the same package at alpha level set at 0.05.

RESULT AND DISCUSSION

Brooding methods and performance

The ambient environmental factors on the growth performance and survivability of marshal broiler chickens are as presented in Table 1. The results from the table showed that early morning ambient temperatures are higher during the two weeks of brooding (24.0^0C – 26.9^0C) as against the last two weeks (22.5^0C – 28.0^0C) when heat supply was discontinued. This could be due to the brooding heat supplied during the night till late in the morning which is higher than the ambient temperature and could have added to the ambient temperature. Sogunle *et al.* (2018) reported that the normally recommended brooding temperatures of 35 ^{0}C, 32 ^{0}C, and 29 ^{0}C for the 1st, 2nd, and 3rd weeks, respectively, could be reduced to 29^0C, 27^0C, and 24^0C when warm-room brooding is used. However, the temperature ranges for the afternoon (25.5^0C – 32.9 ^{0}C) and the evening (24.6^0C – 30.7^0C) did not vary significantly for the 4 weeks of rearing. This can be as a result of reduction in the intensity of the brooding heat during the day time till late in the evening. Carr *et al.* (1974) stated that a brooding temperature as low as 27 ^{0}C during the first week was adequate in warm-room brooding systems. The results of the relative humidity showed that it is mostly highest in the morning followed by the evening time because the heat coming from the sun would reduce the humid in the air by late

Table 1. Ambient environmental factors on the growth performance and survivability of marshal broiler chickens

Week		Temperature (^{0}C)	Humidity (%)	Heated brooding (H)		Heatless brooding (HL)	
		Range	Range	AWW	Mortality	AWW	Mortality
Week 1	M	24.1 – 26.9	77.0 - 93.0				
	A	28.5 – 32.9	48.0 – 94.0	61.56	1/24	64.29	1/24
	E	25.0 – 30.0	66.0 – 87.0				
Week 2	M	24.0 – 25.3	84.0 – 99.0				
	A	27.3 – 31.9	55.0 – 80.0	136.56	0/23	154.54	0/23
	E	24.6 – 30.7	58.0 – 82.0				
Week 3	M	22.5 – 27.3	78.0 – 93.0				
	A	28.4 – 32.5	50.0 – 68.0	127.24	0/23	146.42	0/23
	E	24.6 – 30.5	46.0 – 77.0				
Week 4	M	22.6 – 28.0	88.0 – 99.0				
	A	25.5 – 31.6	57.0 – 85.0	154.04	0/23	150.91	1/23
	E	25.3 – 30.0	69.0 – 90.0				

M = Morning; A = Afternoon; E = Evening; AWW = Average Weekly Weight

morning and once the sun sets by early evening the humid in the air will start building up. Mortality rate was similar at week 1 while H did not record any mortality like HL group.

Post brooding performance and feeding regime

Table 2 shows the post-brooding performance of marshal broiler chickens reared under different brooding methods with varied restricted feeding regime. The average final weight (AFW), average weight gain (AWG) and average feed intake were all observed to be significantly ($P<0.05$) different from one another except average initial weight (AIW). Highest AFW (1337.00 g and 1372.66 g) were recorded in both heated and heatless, respectively for T2 while the least value of 935.00 g was obtained for heated in T3. However, the lowest value of 1164.56 g for heatless was obtained in T2. The birds fed three time daily had constant access to feed but couldn't make use of it probably because of energy dissipated to move around towards the feeder while those fed twice was observed most of the time sitting in one

Table 2: Post-brooding performance of marshal broiler chickens reared under different brooding and restricted feeding methods

Parameters	T1 (8hrs *ad libitum*)		T2 (8hrs and 16hrs)		T3 (8hrs, 12hrs and 16hrs)	
	Heated	Heatless	Heated	Heatless	Heated	Heatless
AIW (4 wks) g	584.29 ±0.15	580.56 ±0.15	580.23 ±0.20	578.42 ±0.15	585.14 ±1.00	583.56 ±0.15
AFW (8 wks) g	1045 ±0.00^{e}	1164.56 ±0.15^{d}	1337.00 ±0.00^{b}	1372.66 ±0.20^{a}	935.00 ±1.50^{f}	1172.49 ±0.20^{c}
AWG (g)	461.14 ±0.15^{e}	529.00 ±0.30^{d}	714.77 ±0.20^{b}	734.24 ±0.35^{a}	379.86 ±2.50^{f}	608.93 ±0.05^{c}
AFI (g)	817.60 ±0.50^{e}	741.51 ±0.50^{d}	1293.46 ±0.04^{a}	1236.97 ±0.50^{b}	741.51 ±0.00^{f}	1157.14 ±0.10^{c}
FCR	1.77	1.81	1.97	1.63	1.68	1.90
Survivability %	100.00	100.00	85.71	100.00	85.71	100.00
PEF (%)	2.84	4.32	2.45	4.15	5.57	4.09

^{a,b,c,d,e,f} = means with the same superscript letters along the row are not significantly ($P>0.05$) different.
AIW = Average initial weight; AFW = Average final weight; AWG = Average weekly gain; AFI = Average feed intake; FCR = Feed Conversion Ratio; PEF = Production Efficiency factor

place and only have to move when food is available in the morning or evening. The average bodyweight of 1.88 kg, 1.81 kg and 1.65 kg attained by Arbor Acre, Ross and Marshal respectively at 8 weeks of age by Udeh and Ogbu (2011) was higher than the result of this study but were in line with the report of Akanno *et al*., (2007) that broiler birds attain a market weight of 1300.00-2000.00g at 8-10 weeks of age. Abdullah *et al*. (2010) reported a higher average bodyweight of 1801.00g for Ross broilers at 7 weeks of age. Highest significantly ($P<0.05$) different AWG value of 734.24 g was recorded for heatless brooding method under T2 while the least significantly ($P<0.05$) different value of 379.86g was obtained in T3 for heated brooding. The least value of 529.00g was recorded for heatless brooding under T1. Twice daily feeding as recorded in T2 had the highest significantly ($P<0.05$) different AFI for both the heated and heatless brooding while the lowest significantly ($P<0.05$) different AFI was recorded for heated in T3 (741.51g) and for heatless in T1 (741.51g). The birds in T2 was observed to most time finished their feed compared to other feeding time. This could be that they are fed during the cool part of the day when energy in form of heat is needed. Feed conversion ratio is one of the major criteria of detecting high performing bird as opined by Rezaei *et al.* (2004) where they stated that FCR and growth rate are conventionally the mode of appraising the performance of broiler birds. The result of FCR in this study showed that the heatless brooding had the lowest numerical value of 1.63 under T2 followed by heated brooding (1.68) still under T2. Amao *et al*. (2015) in their research reported a lower FCR of 1.51 in marshal broiler. The FCR value obtained in this study indicated that birds brooded without heat and fed twice daily had better performance which may sometimes be a function of post-hatching care and management. This indicated that the birds under T2 having received the best brooding (heatless) was also able to utilize the feed given better than others. All the heatless brooded birds were able to survive better (100%) than heated in T2 and T3 which may be due to the fact that the nylon covering was meticulously done to conserve heat. The production efficiency factor (PEF) was highest (5.57 and 2.84) in heated both under T3 and T1, respectively.

Morphometric traits and restricted feeding regime

The morphometric measurements of marshal broiler chickens reared under different restricted feeding methods are presented in table 3. It is known that variations in morphometric traits could provide valuable information for the design of genetic improvement and selection programs for chickens (Shafiq *et al*., 2021). The result from this study showed that all the parameters measured were significantly ($P<0.05$) influenced by the feeding restriction except wing length (Wl). The Bw was highest (1300.00 g) in heatless brooded birds under T2 while the lowest body weight (Bw) of 917.58 g was obtained under T3 for heat brooded birds. The heatless brooded birds under T2 were significantly ($P<0.05$) highest in all the parameters considered and were closely followed by heat brooded birds under T2 in breast length (Brl) and shank length (Shl), and birds under T1 in Brl and breast width (Brw). The morphometric trait, sometimes, is a function of the body weight in which the higher the body weight most times the higher the morphometric traits. The result of this study is in agreement with the

Table 3. Morphometric measurements of marshal broiler chickens reared under different restricted feeding method

Parameters	T1 (8hrs *ad libitum*)		T2 (8hrs and 16hrs)		T3 (8hrs, 12hrs and 16hrs	
	Heated	Heatless	Heated	Heatless	Heated	Heatless
Bw (g)	1294.50 ±96.42^{a}	1280.50 ±86.42^{a}	1011.33 ±47.64^{b}	1300.50 ±90.42^{a}	917.58 ±45.22^{b}	1000.30 ±37.46^{b}
Ht (cm)	33.08 ±1.03^{a}	31.00 ±1.00^{ab}	31.33 ±0.97^{ab}	34.08 ±1.03^{a}	30.85 ±1.03^{b}	29.03 ±0.97^{b}
Brl (cm)	16.84 ±0.53^{a}	16.80 ±0.50^{a}	16.14 ±0.27^{ab}	16.84 ±0.41^{a}	15.52 ±0.38^{b}	15.99 ±0.27^{b}
Brw (cm)	17.00 ±0.60^{a}	15.25 ±0.67^{ab}	14.92 ±1.24^{b}	17.25 ±0.67^{a}	15.44 ±0.45^{ab}	14.00 ±0.24^{b}
Shl (cm)	6.47 ±0.14^{bc}	7.00 ±0.14^{b}	8.17 ±1.33^{a}	8.17 ±0.14^{a}	5.83 ±0.14^{c}	7.10 ±0.33^{b}
Bcl (cm)	3.08 ±0.06^{c}	4.08 ±0.05^{b}	5.84 ±1.91^{a}	5.84 ±0.06^{a}	5.86 ±2.01^{a}	5.84 ±1.91^{a}
Bkl (cm)	21.37 ±0.69^{a}	15.37 ±0.51^{b}	15.03 ±0.51^{b}	21.37 ±0.69^{a}	16.47 ±1.90^{ab}	15.00 ±0.52^{b}
Wl (cm)	14.89 ±0.47	14.88 ±0.37	14.52 ±0.34	14.81 ±0.47	14.01 ±0.22	14.52 ±0.22

^{a,b,c} = means with the same superscript along the row are not significantly (P>0.05) different.
Bw = body weight, Ht = height; Brl = breast length; Brw = breast width; Shl = shank length; Bcl = beak length; Bkl = back length; Wl = wing length

research work of Abe *et al.* (2022) where they recorded a significant (P<0.05) better performance in birds fed in the morning than those fed later in the day. The heatless under T2 had the highest Bw which will make them have the longest measurement in most of the morphometric traits measured. It is also a function of feed intake and FCR which are factors that are superior in heatless under T2. Abe *et al*. (2019) reported a significant (P<0.05) difference in morphometric traits of broiler chickens.

Slaughter yield and restricted feeding regime

Table 4 shows the slaughter yield of marshal broiler chickens fed at different interval. The result showed that the yields were not significantly (P>0.05) different from one another in terms of the weight of the blood, leg, proventriculus and heart. However, the results showed that among the parameters that were significantly (P<0.05) different, birds subjected to heatless brooding under T2 had the highest significant value in live weight (1305.03 g), feather (61.03 g), head (49.99 g), carcass (786.00 g) and liver (38.81 g). Fadare *et al.* (2020) in their research reported 2215.00g slaughter weight for marshal at eight weeks and recorded 94.5 g and 74.5 g for leg and head, respectively which is higher than the value obtained in this study. The result further revealed that the heat brooded birds under T2 recorded similar values in most of the parameters when compared to heatless

Table 4. Carcass and organ of marshal broiler chickens fed at different interval

Parameters	T1 (8hrs)		T2 (8hrs and 16hrs)		T3 (8hrs, 12hrs and 16hrs)	
	Heated	Heatless	Heated	Heatless	Heated	Heatless
Live weight (g)	917.43 ±26.86^{c}	985.03 ±17.09^{b}	1285.03 ±27.09^{a}	1305.03 ±25.00^{a}	946.48 ±24.05^{b}	1005.03 ±19.09^{ab}
Blood (g)	34.98 ±2.90	33.03 ±1.69	34.03 ±2.66	34.13 ±1.69	34.48 ±8.33	34.00 ±1.69
Feather (g)	47.46 ±3.19^{b}	41.03 ±0.06^{b}	61.03 ±0.06^{a}	61.03 ±0.09^{a}	29.48 ±4.86^{c}	31.33 ±0.10^{c}
Head (g)	43.49 ±3.16^{b}	40.53 ±1.10^{b}	49.53 ±1.40^{a}	49.99 ±1.90^{a}	43.98 ±5.73^{b}	49.43 ±1.00^{a}
Leg (g)	54.98 ±1.14	55.03 ±2.69	55.03 ±1.66	57.30 ±1.69	51.95 ±12.08	55.03 ±1.69
Neck (g)	27.48 ±5.47^{c}	38.02 ±5.73^{b}	48.02 ±5.73^{a}	47.00 ±4.73^{a}	25.97 ±6.31^{c}	37.02 ±2.77^{b}
Carcass (g)	531.47 ±9.61^{b}	576.02 ±16.51^{b}	776.02 ±16.00^{a}	786.00 ±26.51^{a}	534.95 ±25.24^{b}	576.11 ±26.51^{b}
Offals (g)	164.97 ±7.26^{c}	167.03 ±8.00^{c}	207.03 ±8.70^{a}	200.00 ±6.66^{a}	194.97 ±4.37^{ab}	177.03 ±8.70^{b}
Proventiculus (g)	6.46 ±0.27	6.02 ±1.11	7.02 ±3.10	7.98 ±1.11	7.47 ±0.82	7.02 ±1.00
Gizzard (g)	26.49 ±2.00^{b}	24.52 ±2.64^{b}	34.52 ±1.66^{a}	34.92 ±2.33^{a}	24.47 ±5.44^{b}	35.55 ±2.64^{a}
Liver (g)	24.98 ±2.87^{b}	28.03 ±2.27^{ab}	38.03 ±2.27^{a}	38.81 ±2.26^{a}	29.98 ±4.00^{ab}	28.53 ±2.61^{ab}
Heart (g)	5.98 ±0.56	6.00 ±1.00	6.02 ±1.11	6.22 ±1.18	5.49 ±0.82	6.02 ±1.21

^{a,b,c} = rows with the same superscript letters are not significantly (P>0.05) different.

brooding. However, birds that were brooded with heat in T1 had the least value of 917.43 g, 531.47 g, 164.97 g and 24.98 g in live weight, carcass, offals and liver, respectively likewise heat brooded birds in T3 had the lowest feather, neck and gizzard weight (29.48 g, 25.97 g and 24.47 g), respectively. However, higher values in liver and gizzard weight by Ojedapo *et al*. (2015) and in heart, liver, intestine, lung weight by Akporhuarho *et al*. (2015) compared to this study.

CONCLUSION

One of the objectives of poultry production is to produce birds with high quality meat with minimum cost. The experiment was able to look at zero cost of brooding and optimize feed consumption geared towards minimal possible broiler production cost. It could be concluded from the result of the experiment that marshal birds reared under heatless brooding performed better than those supplied external heat. Furthermore, the heatless brooded marshal birds recorded the best performance and gave the better slaughter yield when fed twice per day, i.e. in the morning at 8.00 hours and at evening time at 16.00 hours. This means that farmers can adopt marshal birds with heatless brooding and feeding twice daily for improve profitability for better farmers' livelihood.

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