The Influence of Rearing Day-Length and Diet Density on Body Weight of 6 wk-old Broiler Breeders

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Introduction

The objective of rearing broiler breeders is to establish a hen with the potential to maximize the number of saleable chicks it can produce. This means that the breeders must reproduce while still carrying the genetics for growth. This is a problem as ever increasing growth rates have led to a decrease in reproductive efficiency (Bruggeman *et al.*, 1998). In order to try and overcome this, hatching egg producers need to maintain the birds at a defined target BW to achieve reproductive efficiency. It is also important to maintain uniformity within the flock to achieve economic efficiency.

There is debate as to the ability of current breeder guides to predict what the target BW should be (Robbins, *et al.*,1988), as well as the ability of different strains to fit the ideal growth curve (Fattori *et al.* 1991). Current management guides suggest that 8 h of light per day and *ad libitum* feeding is optimal in order for the birds to reach their target BW at 21 d, at which time feed restriction is initiated (Ross Breeders, 1998). However, some hatching egg producers are extending the day-length to 10 hours of light in order to maintain the target BW. This is possibly due to differences between strains or variation in the nutrient composition of feedstuffs. Keeping the birds on target BW is essential for the producer as it dictates when to initiate feed restriction (Wilson *et al.*, 1989). The uniformity of the birds at the time of feed restriction determines the uniformity of the flock at sexual maturity and affects subsequent egg production. Feeding practices are increasingly important as fast growing strains of birds have ovaries which are highly sensitive to over feeding during reproductive development. This can lead to an increased incidence of unsettable eggs (Renema *et al.*, 1999). The practice of feed restriction in young BB has been shown to prevent obesity and excessive BW (Wilson et al., 1989) which is detrimental, as excessively heavy hens show lower egg production and lower fertility (Smith and Hammad, 1985). Sexual maturity is also dependant on the birds reaching a certain age (hypothalamic maturity) as well as BW simultaneously (Abbaker *et al.*, 1994).

Currently broiler breeder pullets and males are reared on 8 h of light. This is thought to act as a form of feed restriction, despite the fact that there are birds which are often full fed to 3 wk of age. There is no clear understanding of how much weight breeder chicks will gain when allowed to eat *ad libitum* for various day-lengths.

The objective of this study was to determine the response of full-fed broiler breeder males and females to 4, 8, 12, or 16 h day-lengths and their response to different nutrient levels in the diet. Parameters measured included weekly BW, feed consumption, mortality, corrected feed conversion ratio, BW uniformity, external growth measurements, and carcass characteristics. Feed consumption of the birds was also monitored during the scotophase of day 41.

Materials and Methods

Bird and Diet Information

This study was conducted on 1,600 Ross 308 broilers mimicking BB. A total of 800 male and 800 females arrived feather sexed. These were raised from day of hatch to 42 days of age. The birds were housed in 32 light-proof floor pens (67.5 ft^2) using straw as litter, with 50 birds per pen. They received feed and water *ad libitum*. The diet was either a BB ration, or a more nutrient dense broiler ration (Table 1) both of which were fed in a mash form. For the first 3 days the birds were on 24-hr of light per day, then starting on day 4 they were exposed to 4, 8, 12, or 16 hours of light per day. A 75 W light was hung inside the pens which provided light at 12 lux.

Traits Measured

Group weights, feed consumption and mortality were recorded once per week and were used to calculate the corrected feed conversion ratio. On day 42 the individual weight of each bird was taken in order to assess BW uniformity of the pen. At this time the ten birds from each pen, which were closest to the mean BW in that pen, had shank length, keel length, girth and chest width measurements taken. At this time these birds were killed by cervical dislocation for carcass analysis which included pectoralis major, minor, total breast muscle and fat pad all which were measured as a percentage of the total BW.

The experimental protocol was reviewed and accepted by the University of Alberta, Faculty of Agriculture, Forestry and Home Economics Animal Policy and Welfare Committee.

Statistical Analysis

Data were analyzed by one-way analysis of variance (ANOVA) using SAS (SAS 1996). When significant differences were determined, comparison among means was made using the Least Significant Difference procedure. Significance was assessed at $P < 0.05$.

RESULTS AND DISCUSSION

On 0 d of this trial there were no significant differences in the average BW of the birds based on any of the treatments (Table 2). This was due to randomized placement of the birds into the pens and the fact that they had not yet been exposed to any of the treatments with the obvious exception of gender. By day 7 there was a significant effect due to the different lighting programs. The birds in the 8 h treatment had a BW measurement which was 15% lower than the average BW from the 4 h, 12 h and 16 h treatments. Again on day 14 the lighting treatment had a significant effect on the average BW of the birds. At this time the birds within the 8 h day-length treatment were still 14% lighter than the average BW of the other three lighting treatments. Interestingly enough however, on day 21 there was no significant difference in average BW of the birds due to the lighting treatments. However, the other treatments began to show differences in

BW. At this time the males were 10% heavier than the females and the birds on the broiler diet were 8% heavier than those on the BB diet. By day 28 all of the treatments significantly affected BW. The birds in the 4 h and 12 h lighting treatments were on average 7% heavier than the 8 h treatment group. The birds within the 16 h treatment did not significantly differ from any of the other groups. By this time the males were only 7% heavier than females. The broiler diet treatment contained birds with an average BW 14% heavier than those on the BB diet. These trends in the data continued as the trial progressed. By day 35 the 8 hr treatment contained birds that were on average 7% lighter than the birds in the other three lighting programs. The males were on average 9% heavier than the females. The birds within the broiler diet treatment were on average 17% heavier than those birds fed the BB diet. On the last day of the trial, day 42, the lighting treatments had produced more defined differences. The 4 h lighting treatment contained birds which were 4% heavier than the 12 h and 16 h treatments and 10% heavier than those birds in the 8 h lighting treatment. Males at this time were 10% heavier than the female treatment groups. The birds fed the broiler ration were the same as the previous week, being 17% heavier than those birds fed the BB ration.

Feed conversion was calculated during this trial and was corrected for mortality (Table 2). On average the 12 h and 16 h treatments contained birds with a 12% poorer feed conversion ratio than the 4 h treatment. The 8 h treatment did not produce significantly different results from any of the other treatments. Feed conversion was not significantly affected by gender. The birds on the broiler diet had 14% higher feed conversion than those birds on the BB diet. This is due to the fact that the BB diet was more nutrient dense.

Flock uniformity is a major concern for broiler breeder producers (Table 3). Uniformity, expressed as the percentage of the flock within 10% of the mean BW, was assessed on day 42 by taking the individual weights of all the birds within the trial. There were significantly fewer males within 10% of mean BW than females. Only 55% of males were within 10% of the mean, while 62% of the females were. When birds were fed the broiler diet they were significantly more uniform in BW than birds fed the BB ration. Of the birds fed the broiler ration 62% were within 10% of the BW mean, while there were only 55% of the birds fed the BB ration were within10% of the mean BW. The 4 h light treatment showed the best uniformity results having 67% of the birds being within 10% of the mean BW. The birds in the 8h lighting treatment had a BW uniformity which was not significantly different from those in the 4 h treatment. The birds within the12 h treatment were not significantly different from those in the 8 h treatment but were significantly different from those in the 4 h treatment with 59% of these birds being within 10% of the mean. The 16 h lighting treatment produced results which were significantly different from all of the other treatments. Uniformity expressed as the percentage of the flock within 15% of the mean BW was also evaluated (Table 3). Again females were significantly more uniform with 80% of them within 15% of the BW mean, while only 73% of the male birds were within these parameters. The broiler diet again produced significantly more uniform birds as there were 79% of this treatment within 15% of the mean, while only

74% of the birds in the BB treatment were within these limits. The lighting treatment which produced the best uniformity was again the 4 h program with 84% of the birds within 15% of the mean BW. Though the 8 h lighting treatment, at 79% uniformity, was not significantly different from the 4 h and the 12 h treatments, these two treatments were different from each other. The birds on the 16 h day-length showed significantly poorer uniformity than the other treatments. Males were less uniform than females in all cases. A longer day length seems to lead to a less uniform flock throughout the different methods of evaluation flock uniformity. The birds within the broiler diet treatment were more uniform in BW than those birds fed the broiler breeder diet. The coefficient of variation for BW was calculated and males were significantly more variable than females (Table 3). There was no significant difference in BW uniformity between birds contained within the two different diet treatments. The lighting treatment had an effect on BW uniformity, the 16 h birds were more variable than the other treatments. The 12 h and 8 h day-length treatments were not significantly different from each other, but were significantly different from the other treatments. The birds exposed to the 4 h lighting treatment were the least variable and significantly different from the other treatment groups. Increasing the day-length led to increased BW variability.

On day 42 male birds were 10% heavier than females on average (Table 4). The feed treatments contained birds with very different average BW; the birds fed the broiler diet were 17% heavier than those fed the BB diet. The lighting treatment did not create much variation. The birds within the 4 h, 12 h and 16 h treatments were not significantly different from each other in regards to average BW. The BW of the birds exposed to 8 h of light were on average 7% lighter than those of the other three treatments.

External measurements on 10 birds per pen closest to the mean BW were taken. These included the BW, shank length, keel length, girth and chest width. On average the shank length of the male birds was 6 mm longer than the female birds. The diet treatments produced significant differences; the birds fed the broiler diet had on average a 4 mm longer shank than those birds fed the BB diet. As one would expect the birds on the more nutrient dense diet were larger. The lighting program did not produce large amounts of variation in keel length. The birds within the 4 h, 12 h, and 16 h treatments were not significantly different from one another. The 8 h treatment had an average shank length 1 mm shorter than all of the other treatments.

The male birds had a longer keel than the females by 4 mm. Since the males were significantly heavier than females it goes to reason that their skeletal structure would also be larger, this is shown by both the shank and keel measurements. The dietary treatments created variation among the birds; those fed the broiler diet had on average 7 mm longer keel lengths than those fed the BB diet. The lighting treatments did not affect keel length to a great extent. The 4 h, 12 h, and 16 h treatments were not significantly different from each other. The birds on the 8 h treatment had on average a significantly shorter keel length than the other treatments by 3 mm. The average girth measurement of the male birds was 7 mm larger than that of the female birds. Girth was also affected by diet. The girth measurement of those birds fed the broiler diet was 20 mm larger than the birds fed the broiler BB ration. Girth was again only mildly affected by light with the 4 h, 12 h and 16 h treatment birds not differing significantly from one another. The birds in the 8 h treatment had significantly smaller girth measurements by 7 mm. The chest width in the male birds was significantly greater than that of the female birds by 2 mm. The birds fed the broiler diet had a significantly larger chest width than those birds fed the BB diet, which were on average 9 mm smaller. The effect of the light treatments follows the same pattern as all of the previous body measurements with 4 h, 12 h, and 16 h treatments not creating significantly different results, while the 8 h treatment was 5 mm smaller.

From the 320 birds dissected, pectoralis major (p. major), pectoralis minor (p. minor), total breast muscle and fadpad were evaluated based on percentage of BW (Table 5). The females had a significantly larger proportion of p. major muscle than the male birds by 4%. The birds fed the broiler diet had 8% more p. major muscle than the birds fed the BB diet. As with the external measurements there was little variation due to the different lighting programs. The 4 h treatment contained birds that on average had 5% more p. major muscle than the other three treatments. Birds within the 8 h, 12 h and 16 h treatments did not significantly differ from one another. The same effect based on gender can be seen for the percentage of p. minor as the females had 5% more than the males. The birds fed the broiler diet had significantly larger (4%) p. minor values than did those birds fed BB diet. There was little variation in the percentage of p. minor based on the lighting treatments. The birds exposed to 4 h of light had significantly more (4 %) p. minor as a percentage of BW than the 8 h and 12 h treatments. The birds exposed to the 16 h day-length were not significantly different from any of the other light treatments. The total breast muscle as a percentage of BW was significantly higher in females by 4% than in the male birds. Birds fed the broiler diets had 7% more breast muscle based on BW than did those birds fed the broiler breeder diet. There was little variation due to the different lighting treatments. The birds within the 4 h and 8 h treatments did not differ from each other or any of the other treatments. The birds on the 16 h treatment had 13% more breast muscle than those birds on the 12 h treatment as a percentage of BW.

The fatpad, (Table 5) expressed as a percentage of BW, was 31% greater in female birds than the males. This is because of the need for female birds to store and utilize lipids for the production of eggs. The dietary treatments did not create any significant differences in the percentage of fatpad found on the bird carcass. The lighting treatments produced very little variation in fatpad as a percentage of BW as the 4 h and 8 h treatments did not differ from each other or any of the other treatments. The only significant differences between the day-length treatments were the 16 h birds which were 13% heavier than the 12 h birds.

This trial produced some very unexpected and interesting results. The 4 h birds were consistently more uniform than all of the other treatments. One would have expected that the shortest day-length treatment would create competition between the birds, leading to more aggressive birds getting more feed and therefore being much heavier. The fact that during this trial feed consumption during the scotophase was monitored may help to explain this phenomenon. It was found that the 4 h birds consumed feed during the dark period. It is postulated that a critically short day-length motivated the birds to eat during the darkness and therefore allowed all of the birds a chance to consume feed at leisure; essentially creating a 24 h day-length with regard to feed consumption. This also moves to explain why the 8 h treatment consistently contained birds with the lowest BW. The birds in the 4 h, 12 h and 16 h treatments were eating to gut capacity, while the 8 h treatment was not and yet was not motivated through hunger to consume feed during the scotophase. It is thought that it was actually the 8 h treatment and not the 4 h treatment which had the shortest day-length. Uniformity was consistently poorer within the longer day-lengths. Throughout the trial males were heavier and had larger external measurements than the females. However, after the evaluation of the internal measurements as a percentage of BW the females had larger p. major, p. minor and total breast muscle, as well as a much larger fatpad. Where the diet treatment created significant differences between the birds those fed the broiler diet were consistently heavier and more uniform than those fed the BB diet. The one measurement which defied convention was the feed conversion ratio, where in this case the birds fed the BB diet had a better feed conversion ratio than those birds fed the broiler diet.

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Table 1. Nutrient density of broiler ration and breeder ration

Ingredient	**Broiler Diet**		**Breeder Diet**	
	Starter (kg)	Grower (kg)	Starter (kg)	Grower (kg)
Corn, Ground	314.3	365.4	349.1	223.8
Oats			102.0	153.6
Oat groats	100.0	150.0	50.0	50.0
Wheat, HRS	118.5	54.9	156.3	310.3
Soybean Meal, 48%	327.2	298.2	140.7	60.6
Canola meal	55.8	34.5	150.0	150.0
Canola Oil	35.1	51.0		
Dicalcium PO_4	19.1	16.9	17.8	18.1
Limestone, ground	11.5	10.6	14.3	14.6
Choline chloride premix	5.0	5.0	5.0	5.0
Broiler Premix	5.0	5.0	5.0	5.0
Salt, NaCl	3.5	3.5	4.0	4.0
D,L-methionine	1.74	1.97	1.33	1.19
L-lysine	1.63	1.37	2.18	2.05
L-threonine			0.54	0.22
Avizyme 1302	0.50	0.50	0.50	0.50
Zinc bacitracin	0.73	0.50	0.73	0.50
Amprol	0.50	0.50	0.50	0.50
TOTAL	**1000.00**	**1000.00**	**1000.00**	**1000.00**

Nutrient	**Broiler Diet**		**Breeder Diet**	
	Starter	Grower	Starter	Grower
Metabolizable energy (Kcal/kg)	3010	3175	2750	2750
Protein (%)	24.0	22.1	20.0	18.0
Linoleic acid (%)	1.73	2.32	1.14	1.00
Fat (%)	6.07	7.95	3.06	2.99
Fibre (%)	3.18	2.89	4.73	5.09
Calcium (%)	1.00	0.90	1.10	1.10
Available phosphorous (%)	0.50	0.45	0.47	0.47
Arginine (%)	1.53	1.41	1.15	0.96
Isoleucine (%)	0.98	0.90	0.77	0.67
Lysine (%)	1.38	1.25	1.10	0.90
Methionine (%)	0.53	0.53	0.45	0.40
Methionine + cystine (%)	0.92	0.88	0.82	0.74
Threonine (%)	0.88	0.80	0.77	0.63
Tryptophan (%)	0.32	0.29	0.24	0.20

TABLE 2a. Weekly Average BW (kg) of Broiler Breeder Pullets

From Day 0 to Day 42

	Age (days)							
	0	7	14	21	28	35	42	CFCR
Source	kg	kg	kg	kg	kg	kg	kg	kg
Light								
4 h	0.044	0.105[a]	0.287[a]	0.600	1.011[a]	1.532[a]	2.064[a]	1.72[b]
8 h	0.044	0.090[b]	0.240[b]	0.557	0.918[b]	1.423[b]	1.862[c]	1.83[ab]
12 h	0.043	0.103[a]	0.268[a]	0.633	0.984[a]	1.518[a]	1.985[b]	1.94[a]
16 h	0.044	0.111[a]	0.280[a]	0.579	0.968[ab]	1.528[a]	1.982[b]	1.99[a]
SEM	0.000	0.003	0.007	0.021	0.019	0.021	0.020	0.174
Gender								
Male	0.044	0.101	0.272	0.623[a]	1.001[a]	1.568[a]	2.078[a]	1.83
Female	0.043	0.103	0.266	0.561[b]	0.931[b]	1.432[b]	1.869[b]	1.90
SEM	0.000	0.002	0.005	0.014	0.013	0.014	0.013	0.117
Diet								
Broiler	0.044	0.102	0.270	0.616[a]	1.046[a]	1.636[a]	2.155[a]	1.73[b]
Broiler Breeder	0.043	0.102	0.268	0.568[b]	0.895[b]	1.365[b]	1.791[b]	2.00[a]
SEM	0.000	0.002	0.005	0.014	0.013	0.014	0.013	0.117

[a-c] Means within a column with no common superscript differ significantly ($P \leq 0.05$).

where CFCR= corrected feed conversion ratio

Light= day length in hours

TABLE 2b. Two-way Interactions of Weekly Average BW (kg) of Broiler Breeder Pullets From Day 0 to Day 42

	Age (days)			
	14	28	35	42
Source	kg	kg	kg	kg
Light x Gender				
F x 4				1.939[c]
F x 8				1.796[e]
F x 12				1.900[cd]
F x 16				1.840[de]
M x 4				2.189[a]
M x 8				1.928[c]
M x 12				2.069[b]
M x 16				2.125[ab]
SEM				0.031
Diet x Light				
B x 4	0.290[a]	1.117[a]	1.714[a]	2.287[a]
B x 8	0.256[b]	1.024[b]	1.599[b]	2.118[b]
B x 12	0.252[bc]	1.020[bc]	1.600[b]	2.085[b]
B x 16	0.281[ab]	1.022[b]	1.632[b]	2.132[b]
BB x 4	0.284[a]	0.904[d]	1.351[d]	1.841[c]
BB x 8	0.225[c]	0.813[e]	1.246[e]	1.606[d]
BB x 12	0.285[a]	0.948[c]	1.437[c]	1.884[c]
BB x 16	0.278[ab]	0.913[d]	1.425[cd]	1.833[c]
SEM	0.011	0.029	0.033	0.031

[a-e] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where M=male F=female, BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours

TABLE 2c. Three-way Interactions of Weekly Average BW (kg)

of Broiler Breeder Pullets From Day 0 to Day 42

	Age (days)
	42
Source	kg
Gender x Diet x Light	
F x B x 4	2.115^{d}
F x B x 8	2.001^{def}
F x B x 12	2.049^{de}
F x B x 16	1.979^{ef}
F x BB x 4	1.762^{g}
F x BB x 8	1.592^{i}
F x BB x 12	1.751^{g}
F x BB x 16	1.700^{gh}
M x B x 4	2.458^{a}
M x B x 8	2.236^{bc}
M x B x 12	2.122^{cd}
M x B x 16	2.284^{b}
M x BB x 4	1.920^{f}
M x BB x 8	1.621^{hi}
M x BB x 12	2.016^{def}
M X BB x 16	1.967^{ef}
SEM	0.050

$^{a-i}$ Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where M=male F=female, BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours

TABLE 3a. Weekly Average Feed Consumption

of Broiler Breeder Pullets from Day 0 to Day 42

	Age (wk)					
Source	0-7 kg	7-14 kg	14-21 kg	21-28 kg	28-35 kg	35-42 kg
Light						
4 h	0.088	0.244[b]	0.473[b]	0.731[b]	1.003[b]	1.165[a]
8 h	0.079	0.208[c]	0.440[b]	0.693[b]	0.947[b]	1.062[b]
12 h	0.092	0.255[ab]	0.475[b]	0.822[a]	1.074[a]	1.207[a]
16 h	0.099	0.267[a]	0.526[a]	0.867[a]	1.098[a]	1.215[a]
SEM	0.008	0.007	0.015	0.025	0.025	0.029
Gender						
Male	0.086	0.242	0.489	0.801	1.081[a]	1.226[a]
Female	0.093	0.245	0.469	0.755	0.979[b]	1.099[b]
SEM	0.005	0.004	0.010	0.017	0.017	0.019
Diet						
Broiler	0.087	0.233[b]	0.470	0.796	1.057[a]	1.120[a]
Broiler Breeder	0.092	0.254[a]	0.487	0.760	1.004[b]	1.129[b]
SEM	0.005	0.004	0.010	0.017	0.017	0.019

[a-c] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where CFCR= corrected feed conversion ratio
Light= day length in hours

TABLE 4a. Uniformity of Broiler Breeder Pullets at day 42 based on Coefficient of Variation (CV) and Proximity (10/15%) to the Mean BW

	Parameters measured		
Source	CV	+/- 10%	+/- 15%
Light			
4 h	10.6[c]	66.8[a]	84.5[a]
8 h	13.0[b]	59.9[ab]	79.4[ab]
12 h	13.7[b]	59.0[b]	74.9[b]
16 h	16.7[a]	50.9[c]	67.2[c]
SEM	0.55	0.02	0.02
Gender			
Male	14.1[a]	55.8[b]	73.4[b]
Female	12.8[b]	62.4[a]	79.6[a]
SEM	0.39	0.02	0.01
Diet			
Broiler	13.0	62.8[a]	79.0[a]
Broiler Breeder	14.0	55.5[b]	74.0[b]
SEM	0.39	0.02	0.01

[a-c] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
Light= day length in hours
Proximity refers to the number of birds with a body weight within 10 or 15 % of the mean body weight

TABLE 4b. Three-Way Interactions of Uniformity of Broiler Breeder Pullets
at day 42 based on Coefficient of Variation (CV) and Proximity (10/15%) to the Mean BW

	Parameters measured
Source	+/- 15%
Gender x Diet x Light	
F x B x 4	90.9[a]
F x B x 8	84.9[abc]
F x B x 12	81.7[abcd]
F x B x 16	70.4[efg]
F x BB x 4	85.1[abc]
F x BB x 8	80.6[abcde]
F x BB x 12	73.2[def]
F x BB x 16	70.3[efg]
M x B x 4	84.7[abc]
M x B x 8	87.8[ab]
M x B x 12	68.4[fg]
M x B x 16	63.4[g]
M x BB x 4	77.2[bcdef]
M x BB x 8	64.5[g]
M x BB x 12	76.4[cdef]
M x BB x 16	64.6[g]
SEM	0.04

[a-g] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where M=male F=female, BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours
Proximity refers to the number of birds with a body weight within 10 or 15 % of the mean body weight of the flock

TABLE 5a. Effect of Day length, Gender and Diet Density on the Average BW and External Measurements of Broiler Breeder Pullets at day 42

	Parameters measured				
Source	BW kg	Shank mm	Keel mm	Girth mm	Chest Width mm
Light					
4 h	1.95^{a}	100.2^{a}	129.0^{a}	292.5^{a}	75.7^{a}
8 h	1.80^{b}	98.8^{b}	125.7^{b}	284.7^{b}	70.1^{b}
12 h	1.94^{a}	100.7^{a}	127.9^{a}	291.7^{a}	74.8^{a}
16 h	1.93^{a}	100.3^{a}	128.4^{a}	291.4^{a}	75.6^{a}
SEM	0.01	0.46	0.68	1.19	0.71
Gender					
Male	2.01^{a}	103.0^{a}	129.8^{a}	293.6^{a}	74.8^{a}
Female	1.80^{b}	97.0^{b}	125.7^{b}	286.4^{b}	73.2^{b}
SEM	0.01	0.33	0.48	0.84	0.50
Diet					
Broiler	2.08^{a}	102.1^{a}	131.2^{a}	300.0^{a}	78.5^{a}
Broiler Breeder	1.73^{b}	97.7^{b}	124.2^{b}	280.0^{b}	69.7^{b}
SEM	0.01	0.33	0.48	0.84	0.50

[a-b] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
Light= day length in hours

TABLE 5b. Significant Two-way Interactions Between Day length, Gender and Diet Density on the Average BW and External Measurements of Broiler Breeder Pullets at day 42

	Parameters measured				
Source	BW kg	Shank mm	Keel mm	Girth mm	Chest Width mm
Diet x Light					
B x 4	2.16^{a}	102.4^{a}	133.5^{a}	304.7^{a}	81.7^{a}
B x 8	2.03^{c}	102.2^{a}	130.4^{bc}	298.3^{b}	75.7^{c}
B x 12	2.05^{bc}	101.7^{a}	129.2^{cd}	298.5^{b}	77.6^{bc}
B x 16	2.09^{b}	102.3^{a}	132.0^{ab}	298.8^{b}	78.9^{b}
BB x 4	1.73^{e}	98.0^{b}	124.6^{e}	280.3^{c}	69.7^{d}
BB x 8	1.57^{f}	95.4^{c}	121.0^{f}	271.0^{d}	64.6^{e}
BB x 12	1.83^{d}	99.8^{b}	126.6^{de}	284.8^{c}	72.1^{d}
BB x 16	1.78^{de}	98.4^{b}	124.8^{e}	284.0^{c}	72.3^{d}
SEM	0.02	0.66	0.96	1.68	1.01
Diet x Gender					
F x B	1.95^{b}	98.6^{c}			
F x BB	1.64^{d}	95.3^{d}			
M x B	2.21^{a}	105.6^{a}			
M x BB	1.81^{c}	100.4^{b}			
SEM	0.01	0.46			
Gender x Light					
F x 4	1.82^{bc}				
F x 8	1.73^{d}				
F x 12	1.84^{bc}				
F x 16	1.79^{cd}				
M x 4	2.07^{a}				
M x 8	1.86^{b}				
M x 12	2.04^{a}				
M x 16	2.08^{a}				
SEM	0.02				

$^{a\text{-}f}$ Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where M=male F=female, BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours

TABLE 6a. Effect of Day length, Gender and Diet Density on the Carcass Characteristics of Broiler Breeder Pullets at day 42

	Parameters measured as a Percentage of BW			
Source	P.major %	P.minor %	Breast Muscle %	Fatpad %
Light				
4 h	14.10^{a}	3.71^{a}	17.82^{a}	1.30^{ab}
8 h	13.14^{b}	3.51^{b}	16.65^{b}	1.30^{ab}
12 h	13.48^{b}	3.59^{b}	17.07^{b}	1.27^{b}
16 h	13.50^{b}	3.62^{ab}	17.12^{b}	1.47^{a}
SEM	0.15	0.04	0.18	0.06
Gender				
Male	13.30^{b}	3.48^{b}	16.79^{b}	1.11^{b}
Female	13.81^{a}	3.73^{a}	17.54^{a}	1.56^{a}
SEM	0.11	0.03	0.13	0.04
Diet				
Broiler	14.12^{a}	3.71^{a}	17.84^{a}	1.29
Broiler Breeder	12.99^{b}	3.50^{b}	16.49^{b}	1.38
SEM	0.11	0.03	0.13	0.04

$^{a-b}$ Means within a column with no common superscript differ significantly ($P \leq 0.05$).
Light= day length in hours

TABLE 6b. Two-way Interactions of Day length, Gender and Diet Density on the Carcass Characteristics of Broiler Breeder Pullets at day 42

	Parameters measured as a Percentage of BW		
Source	P.major %	Breast Muscle %	Fatpad %
Diet x Light			
B x 4	14.87^{a}	18.74^{a}	1.40^{ab}
B x 8	13.93^{bc}	17.58^{bc}	1.28^{bc}
B x 12	13.70^{bcd}	17.32^{bcd}	1.14^{c}
B x 16	13.99^{b}	17.71^{b}	1.34^{bc}
BB x 4	13.33^{cde}	16.89^{cde}	1.21^{bc}
BB x 8	12.35^{f}	15.72^{f}	1.32^{bc}
BB x 12	13.27^{de}	16.82^{de}	1.40^{ab}
BB x 16	13.00^{e}	16.52^{e}	1.60^{a}
SEM	0.22	0.26	0.09

$^{a-f}$ Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours

TABLE 6c. Three-way Interactions of Day length, Gender and Diet Density on the Carcass Characteristics of Broiler Breeder Pullets at day 42

	Parameters measured as a Percentage of BW		
Source	P.major %	P.minor %	Breast Muscle %
Gender x Diet x Light			
F x B x 4	15.36[a]	4.07[a]	19.43[a]
F x B x 8	14.43[b]	3.82[bc]	18.25[b]
F x B x 12	14.39[b]	3.87[ab]	18.26[b]
F x B x 16	13.88[bc]	3.74[bcd]	17.62[bcde]
F x BB x 4	13.76[bcd]	3.67[bcdef]	17.43[bcdef]
F x BB x 8	12.73[fg]	3.52[defgh]	16.26[g]
F x BB x 12	12.89[ef]	3.53[defgh]	16.42[fg]
F x BB x 16	13.01[def]	3.63[bcdefg]	16.64[efg]
M x B x 4	14.38[b]	3.66[bcdef]	18.04[bc]
M x B x 8	13.43[cdef]	3.48[efghi]	16.91[defg]
M x B x 12	13.02[def]	3.36[hi]	16.38[g]
M x B x 16	14.10[bc]	3.71[bcde]	17.80[bcd]
M x BB x 4	12.91[def]	3.45[fghi]	16.36[g]
M x BB x 8	11.96[g]	3.23[i]	15.19[h]
M x BB x 12	13.64[bcde]	3.58[cdefgh]	17.21[cdef]
M x BB x 16	13.00[def]	3.40[ghi]	16.41[g]
SEM	0.31	0.09	0.36

[a-i] Means within a column with no common superscript differ significantly ($P \leq 0.05$).
where M=male F=female, BB=Broiler Breeder Diet B=Broiler Diet, Light= day length in hours