Interaction of Feeding Time and Temperature and Their Relationship to Performance of the Broiler Breeder Hen

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ABSTRACT Experiments with broiler breeder hens were undertaken to determine effect of feeding time and environmental temperature on various production variables, body weight, and feed consumption. Two temperature treatments were used: low cyclic temperature (10 to 25 C), and high cyclic temperature (21 to 39 C). The three feeding treatments were: fed one daily meal either at 0700 h (Treatment 1) or 1800 h (Treatment 2), or one-half the daily amount at 0700 h and the other half at 1800 h (Treatment 3). In another experiment, hens were assigned to feeding times of either 0700 or 1800 h. Feeding time and temperature did not markedly affect rate of egg production; however, hens at high temperature fed two meals per day produced the fewest eggs. High temperature caused significant reductions in egg weight, specific gravity, and shell thickness. Feeding time and temperature had no effect on time of oviposition, ovulation, or the transit time of the egg through the oviduct. Significant body weight loss occurred in hens at high temperature and fed at 0700 h. Both high temperature and feeding one-half of the daily feed at 0700 and the other half at 1800 h caused a reduction in feed consumption.

{*Key words:* broiler breeder, feeding time, temperature)

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INTRODUCTION

It is common practice for broiler breeder hens to be provided a limited amount of feed each morning. Changing time of feeding (from morning to afternoon) was among many experimental alternatives used to improve eggshell quality of broiler breeder hens maintained under optimal environmental conditions (Balnave, 1977; Bootwalla *et al,* 1983; Wilson and Keeling, 1991), but observed effects on the rate of egg production were varied. Some workers have found that afternoon feeding resulted in a higher rate of egg production (Balnave, 1977; Bootwalla *et at,* 1983), whereas others reported no effect (Wilson and Keeling, 1991). Brake and Peebles (1986) and Harms (1991) observed a decline in egg production when feeding time was changed from morning to afternoon. Wilson and Keeling (1991) speculated that a change in ovulation time, or increased transit time of the egg through the oviduct, may be responsible for the delay in time of oviposition observed when broiler breeder hens were fed in the afternoon.

and Schnepel, 1940; Harrison and Beillier, 1969; Miller and Sunde, 1975; de Andrade *et al,* 1977; Emery *et al,* 1984). Similar to the effect of afternoon feeding, high cyclic temperatures have been reported to delay time of oviposition (Miller and Sunde, 1975). It is not known whether feeding late in the day can be used as a means to ameliorate the effects of heat stress on eggshell quality. Therefore, the objectives of this study were to determine the effects of ti me of feeding and cyclic temperatures and their interaction on rate of egg production, eggshell quality, time of ovulation and oviposition, body weight change, and feed consumption patterns of broiler breeder hens.

MATERIALS AND METHODS

Experiment 1

Thirty-eight-week-old Arbor Acres broiler breeder hens were moved to individual laying cages (60 x 40 x 45 cm) in two environmentally controlled chambers and during a 2-wk adjustment period were fed 178 g/d of a compIetereea^TaDle^^rTO/^TTr^na^r^
we had previously determined that this level of feed intake maximized egg production of broiler breeders (Robbins *et al,* 1988). Hens had free access to water from cup drinkers connected to water containers that were placed above the cage. Hens received 17 h light (0700 to 2400 h) and 7 h darkness. Treatments were factorially arranged and consisted of two temperatures and three feedfne reefmens. Hens were randomlv assigned to each

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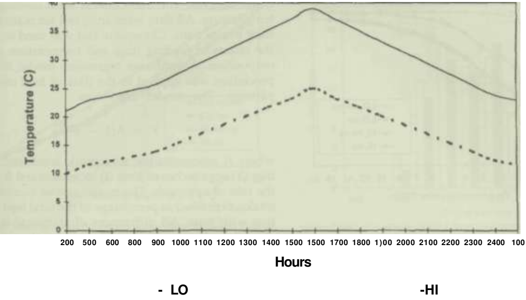

FIGURE 1. The daily temperature cycle, Experiment 1.

treatment. Within treatment, 10 hens were randomly assigned to each of two replicate groups. Feeding treatments were: Treatment 1, fed one meal at 0700 h; Treatment 2, fed at 1800 h; and Treatment 3, fed half of the meal at 0700 h and the other half at 1800 h. Two temperature treatments were imposed; Treatment 1 (LO), and 2 (HI) were cycled daily from a low of either 10 or 21 C at 0300 h to a peak of either 25 or 39 C, respectively, at 1600 h (Figure 1). No control of humidity was attempted. Egg production was recorded daily. Egg weight, specific gravity, and shell thickness were obtained from eggs collected during the last 3 d of every week. Egg weight was recorded at the end of the day. Egg specific gravity was determined the following morning by using the flotation method (Voisey and Hamilton, 1977), taking measurements from 1.062 to 1.102 in increments of 0.004. The eggs were washed and allowed to dry at room temperature for 24 h; a piece of (membrane-free) shell was obtained from the egg equator and shell thickness was measured with a micrometer. Individual water consumption was measured daily. Feed consumption patterns were determined on Days 13 and 27 of the experiment. Feed intake was measured for each group (all hens), starting at the time the feed was served and every 30 min for 3 h, then every hour for 5 h and every 2 h thereafter until the feed was gone. On Day 36 of the experiment, individual body weight was recorded and body weight change was determined.

TABLE 1. Composition of diet

Composition of diet	Percentage
Yellow corn	64.06
Soybean meal	18.0
Alfalfa meal	6.5
Menhaden fishmeal	2.5
Defluorinated rock phosphate	1.62
Limestone	6.2
Vitamin-trace mineral mix[1]	0.65
Salt	0.35
DL-methionine	0.10
Manganese sulfate	0.025
Calculated analyses	
Crude protein	17.0
Metabolizable energy, kcal/kg	2,748.0
Calcium	3.16
Available phosphorus	0.48
Arginine	1.13
Isoleucine	0.82
Lysine	[illegible]
Methionine + cy[illegible]	[illegible]
Threonine	0-70
Tryptophan	0.21
Valine	0.96
Chemical analyses	
Calcium, %	3.21
Phosphorus, %	0.744

[1]Provided per kilogram of diet: vitamin A (retinyl acetate), 10,010 IU; cholecalciferol, 2,145 IU; riboflavin, 6.43 mg; vitamin E, 17.9 IU; choline, [illegible] mg; niacin, 28.6 mg; pantothenic acid, 8.58 mg; pyridoxine, 3.58 mg; thiamine, 1.43 mg; menadione, 1.43 mg; folic acid, 0.72 mg; biotin, 0.14 mg; vitamin B_{12}, 0.009 mg; Fe, 64 mg; Mn, 64 mg; Zn, 49 mg; Cu, 5.2 mg; I, 0.25 mg; Se, 0.19 mg.

This experiment was conducted with 3'8-wk-old Indian River broiler breeder hens. Two hundred hens were moved to individual laying cages in two environmentally controlled chambers. For 3 wk (adjustment and pretreatment periods) the hens continued to receive 178 g/hen-d of feed (Table 1) at 0700 h and artificial light from 0700 to 2400 h. Sixty of the 100 hens in each house were selected and divided into four groups of 15 hens each. Hens utilized in the experiment had: 1) laid at least 12 eggs in

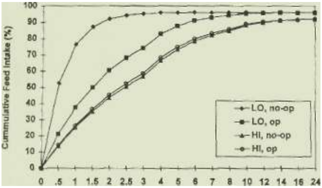

FIGURE 2. Effect of temperature and laying status of broiler breeder hens (fed at 0700 h) on rate of feed consumption (expressed as percentage of mean daily feed intake). LO and HI indicate low and high cyclic temperatures, respectively. No-op indicates a non-oviposition day and op indicates an oviposition day. Parameters (A and B) of the equation [$Y = A(1 - e^{-Bt})$] for hens at LO are: 0.96 and 1.59 (no-op) and 0.96 and 0.496 (op). At HI, A and B are: 0.92 and 0.32 (no-op) and 0.92 and 0.338 (op). Number of hens observed was: LO, no-op 1; LO, op 19; HI, no-op 6; and HI, op 14.

the 20-d pre treatment period; and 2) laid at least three eggs in a sequence. The Treatment 1 hens in each chamber continued to receive their daily feed allowance at 0700 h, whereas the hens in Treatment 2 were switched to receive their daily feed allowance at 1800 h. The remainder of the 100 hens in each chamber were also divided into two feeding treatments and were set aside for future use. The same temperature treatments were used as in Experiment 1. Egg production was recorded daily. Egg weight, specific gravity and shell thickness were obtained from all eggs produced during the last 3 d every week of the 6-wk experimental period. Time of oviposition was recorded hourly from 0700 to 1800 h for 5 consecutive d during the 4th wk and for 4 d during the last week of the experiment. Eggs were classified into 12 different groups based on time of observed oviposition. During Week 6 and 7, a total of 113 hens were killed by cervical dislocation at 1, 4, 6, and 8 h after oviposition. Prior to killing of hens, oviposition was checked every 10 to 15 min (from 0700 to 1600 h). In all cases, only hens that laid the first or the second egg in a sequence were killed. This procedure increased the probability that ovulation of the following egg had occurred. With regard to hens killed 1 h after oviposition, ovulation and the position of the ova was verified. For hens killed at 4, 6, and 8 h after oviposition, the length of the magnum and isthmus was measured and the distance traversed by the growing egg was recorded.

Statistical Analysis

Data for egg production, egg weight, specific gravity, shell thickness, interval between two successive ovipositions {op-op interval), body weight change, daily feed and water consumption were subjected to the ANOVA using the General Linear Models procedure of SA5® (SAS Institute, 1985. The main effects were feeding time and temperature. All data were analyzed for main effects and their interactions. Chi-square test was used to determine the effects of feeding time and temperature on time of oviposition. A nonlinear regression model fitting SAS® procedure was applied to the data of feed consumption patterns. The model used was

$$Y = A(1 - e^{-Bt})$$

where A represents the asymptotic level feed consumption (Y) approaches as time (t) increases; and B represents the rate of approach. The model relates cumulative feed intake, expressed as percentage of the total feed consumption with time. All differences of statistical significance were based on a $P < 0.05$ unless otherwise stated.

RESULTS

Experiment 1

Hens housed under high vs low temperature consumed more water and produced lighter eggs that had lower specific gravities and thinner shells (Table 2). When compared to hens fed once per day in either the morning or evening, hens fed their feed allowance in two meals experienced reduced egg production and shorter oviposition-oviposition intervals (op-op) only when housed under the high temperature. Both high temperature and meal feeding times were observed to reduce feed intake but the effects were not additive. Exposure to the high cyclic temperature resulted in a significant reduction in feed intake of birds fed at 0700 and 1800 h. At low cyclic temperature, hens fed their daily allowance in two meals ate significantly less feed than hens fed at either 0700 or 1800 h. At high temperature, water consumption increased in all the feeding groups.

The results with respect to feed consumption revealed different patterns between the two cyclic temperatures (Figures 2 to 4). Parameters of model 1 for each feeding group were estimated. Hens in the different feeding groups were further divided into subgroups based on whether or not an egg was laid on the day the measurements were taken. The results indicate: 1) HI resulted in significantly slower rate of feed consumption by all hens in the different feeding groups regardless of whether they laid or did not lay an egg (an exception was the hens fed twice daily whose rate of feed consumption was not significantly different from that of hens fed twice daily and maintained at low temperatures); 2) by 5 h after feed was served, hens at LO consumed more of their feed allowance than at HI; 3) at LO, hens that did not lay an egg and were fed at 0700 h and those fed twice daily ate more and had higher rates of feed consumption than hens that laid an egg; 4) hens fed at 1800 h that had laid an egg ate more feed more quickly than hens that did not lay an egg the same day; 5) at HI, rates of feed consumption of hens that did not lay an egg and those that laid an egg did not differ regardless of the hen's feeding group.

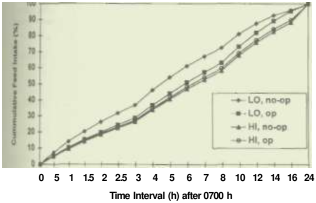

FIGURE 3. Effect of temperature and laying status of broiler breeder hens (fed at 0700 and 1800 h) on rate of feed consumption (expressed as percentage of mean daily feed intake). LO and HI indicate low and high cyclic temperatures, respectively. No-op indicates a non-oviposition day and op indicates an oviposition day. Parameters (A and B) of the equation [$Y = A (1 - e^{-Bt})$] for hens at LO are: 1.08 and 0.139 (no-op) and 129 and 0.084 (op). At HI, A and B are; 1.21 and 0.082 (no-op) and 0.085 (op). Number of hens observed was: LO, no-op 6; LO, op 14; HI, no-op 13; and HI, op 6.

Experiment 2

The number of eggs produced per hen was not affected by feeding time or temperature (Table 3); however, high temperatures caused a significant reduction in egg specific gravity and a corresponding though nonsignificant reduction in shell thickness. There were no differences in time intervals between successive ovipositions {Table 4) in hens housed at different temperatures. Distribution of oviposition times were influenced by feeding time (Figures 5 and 6). Chi-square test comparing the distribution of ovipositions for hens fed at 0700 h to those of hens fed at 1800 h

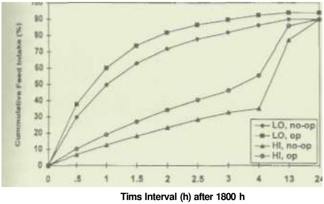

FIGURE 4. Effect of temperature and laying status of broiler breeder hens (fed at 1800 h) on rate of feed consumption (expressed as percentage of mean daily feed intake). LO and HI indicate low and high cyclic temperatures, respectively. No-op indicates a non-oviposition day and op indicates an oviposition day. Parameters (A and B) of the equation [$Y = A (1 - e^{-Bt})$] for hens at LO are: 0.9 and 0.8 (no-op) and 0.94 and 1.02 (op). At HI, A and B are: 0.9 and 0.15 (no-op) and 0.9 and 0.24 (op). Number of hens observed was: LO, no-op 1; LO, op 19; HI, no-op 7; and HI, op 13.

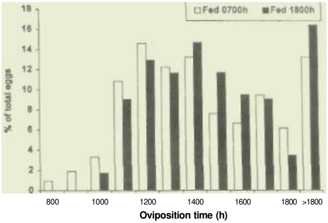

FIGURE 5. Frequency distribution (percentage) of oviposition times for broiler breeder hens maintained under low temperatures and fed at 0700 (n = 212 eggs) and 1800 h (n = 232 eggs).

was significantly different when temperature treatment was ignored {Figure 7). Hens fed at 0700 h laid 59.2% of their eggs before 1400 h vs 53% for hens fed at 1800 h. Neither feeding time nor temperature treatment caused a significant modification in the distribution of oviposition times of the first-of-sequence eggs (Figures 8 and 9). Neither the temperature regimens nor feeding time seemed to affect the time of ovulation, or the time the egg spent in the oviduct.

DISCUSSION

No temperature treatment effects on number of eggs produced were observed. These results are consistent with those of Miller and Sunde (1975); Deaton *et al.* (1981, 1982); and Emery *et al* (1984). These authors reported that high cyclic temperatures with a wide maximum-minimum range did not adversely affect rate

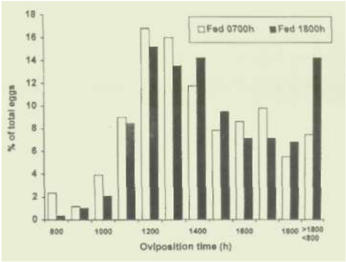

FIGURE 6. Frequency distribution (percentage) of oviposition times for broiler breeder hens maintained under high temperatures and fed at 0700 (n = 245 eggs) and 1800 h (n = 296 eggs).

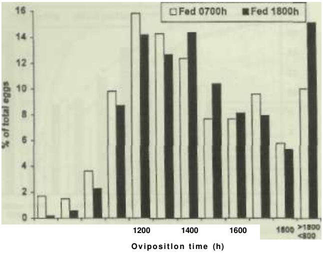

FIGURE 7. Frequency distribution (percentage) of oviposition times for broiler breeder hens maintained under low temperatures and fed at 0700 (n - 468 eggs) and 1800 h (n = 528 eggs).

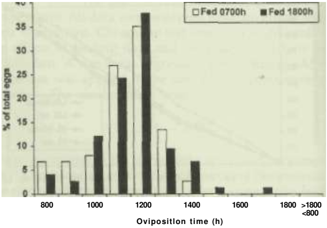

FIGURE 9. Frequency distribution (percentage) of oviposition times of first-of-sequence eggs for broiler breeder hens maintained under high temperatures and fed at 0700 (n = 74 eggs) and 1800 h (n = 74 eggs).

of egg production in commercial layers. In the current study, egg weight, specific gravity, and shell thickness were reduced in hens exposed to HI. Similar effects of high temperatures on eggshell quality have been previously reported (Smith and Oliver, 1972a,b; Miller and Sunde, 1975; de Andrade *et al,* 1977; Emery *et al,* 1984).

Bootwalla *et al.* (1983) and Wilson and Keeling (1991) reported that feeding in the afternoon did not adversely affect egg production; however, Harms (1991) reported that changing the feeding time from 0800 to 1600 h reduced rate of egg production. In the current study, rate of egg production was not affected by feeding time. Birds had a 2-wk adjustment period before data collection and this may have prevented the adverse effects observed by Harms (1991). Egg weight was not affected by feeding time. These results are inconsistent with previous reports (Cave, 1981; Daniel and Balnave, 1981; Farmer *et al,* 1983) wherein meal feeding or feeding in the afternoon increased egg weight, but confirm those of Harms (1991) and Wilson and Keeling (1991). Egg specific gravity was not affected by feeding time, which is in agreement with Wilson and Keeling (1991). Eggs from hens in HI had significantly lower specific gravity compared to those of hens at LO. Thus, it appears that temperature has a greater effect on eggshell calcification than does time of feeding.

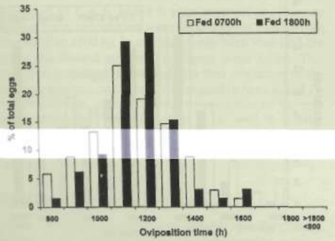

FIGURE 8. Frequency distribution (percentage) of oviposition times of first-of-sequence eggs for broiler breeder hens maintained under low temperatures and fed at 0700 (n = 68 eggs) and 1800 h (n = 65 eggs).

Harms (1991) reported that, under thermoneutral conditions, feeding broiler breeder hens at 1600 h resulted in a significant BW loss in one of two experiments, even though the hens that lost weight ate more and laid fewer eggs compared to hens fed at 0800 h. By contrast, the results of present study indicate that the hens at LO gained weight regardless of the feeding time. This disagreement could be due to the fact that the hens in the study conducted by Harms (1991) were 52 wk of age whereas 39-wk-old hens were used in the present study. Compared to hens at LO, hens fed at 0700 h experienced significant BW loss (37.9 g) when housed under the high temperatures.

Hens exposed to the high temperatures consumed significantly more water compared to hens maintained under low cyclic temperatures regardless of feeding time. Also, hens fed at 0700 h and maintained at HI consumed lUU mL per nen per d more water tnan nens fed at 1800 h, suggesting that feed consumption before peak temperature enhanced additional water intake.

Under thermoneutral conditions, 53-wk-old broiler breeder hens, kept on floor pens, consumed their daily feed allowance in approximately 3 to 4 h (Farmer *et al,* 1983). The results of this observational trial revealed different patterns for the changes in feed consumption due to the high cyclic temperatures. At LO, resting hens

TABLE 2. Performance characteristics of broiler breeder hens fed at 0700, or 1800 h, and twice daily and maintained under LO (10 to 25 C) or HI (21 to 39 C) cyclic temperatures, Experiment 1

		Time of feeding		
Characteristics	Temperature	0700 h	Split-diet[1]	1800 h
Eggs per hen[2]	LO	21.1 ± 0.69>	22.0 ± 0.76"	21.2 ± 0.67'
	HI	22.0 ± 0.69>	18.0 ± 0.69"	20.0 ± 0.67'
Egg weight, g	LO	69.9 ± 0.69>	71.8 ± 0.91"	71.6 ± 0.91'
	HI	65.5 0.91t>	66.3 ± 0.91^	65.7 ± 0.91»
Egg specific gravity	LO	1.085 ± 0.0009"	1.0854 ± 0.0009"	1.0863 ± 0.0009'
	HI	1.0808 ± 0.0009b	1.0788 ± 0.0009b	1.0824 ± 0.0009b
Eggshell thickness, mm	LO	0.3542 ± 0.006'	0.3598 ± 0.006"	0.3681 ± 0.006'
	HI	0.3293 ± 0.006[b]	0.3265 ± 0.006»	0.3390 ± 0.006b
Op-op interval,[3] h	LO	26.5 ± 0.27"	26.1 ± 0.27"	27.7 ± 0.27"
	HI	26.2 ± 0.27"	25.9 ±	26.3 ± 0.27"
Body weight change, g	LO	101.1 ± 39.9"	102.0 ± 37.9'	90.0 ± 37.9'
	HI	-37.9 ± 38.9"	-8.8 ± 37.9«f	19.5 ± 37.9
Feed consumption, g/d	LO	170.9 ± 4.6'	154.8 ± 4.6b	164.4 ± 4.6'
	HI	151.7 ± 4.7"	148.3 ± 4 >	142.6 ± 4.6b
Water consumption, mL/d	LO	385.7 ± 37b	329.8 ± 37b	318.7 ± 37b
	HI	756.0 ± 37'	652.3 37"	660.8 ± 37'

[ab]Means ± SEM within a variable with no common superscript differ significantly *($P < 0.05$).*

'Birds were fed half their daily allowance at 0700 h and the other half at 1800 h.

[2]Number of eggs produced per hen per 28-d period.

interval between two successive ovipositions, based on data collected on 3-d period every week.

fed at 0700 h or those fed the split-meal ate more and faster than hens that had laid an egg that day (173.5 vs 170.7 g and 162.2 vs 151.7 g per hen per d, respectively). This is consistent with the work of Roland *et al.* (1972), who reported that more feed was consumed by layers on nonoviposition days than on oviposition days. The opposite was true for hens fed at 1800 h (164.4 vs 165.1 g per hen per d). These results indicate that there is a relationship between feed consumption and oviposition, as hens fed at 1800 h and that had laid eggs earlier in the day ate more and faster than those that did not lay eggs on that day. At HI, resting hens fed at 0700 or 1800 h ate more but not faster than hens that had eggs on that day (152.6 vs 151.4 and 145.6 vs 140.9 g per hen per d). The opposite was true for the hens fed the split-meal (141.6 vs 152.2 g per hen per d). Therefore, it seems that oviposition has a less pronounced role in regulating feed consumption in hens maintained under high temperatures. Hens fed at 1800 h consumed less feed and ate faster than hens fed at 0700 h even though these hens gained weight and produced eggs with better shell quality. Therefore, it seems that feeding at 0700 h, when the temperature was increasing, was more stressful than feeding at 1800 h when the temperature was declining.

Both cyclic temperature and meal feeding were observed to cause a delay in time of oviposition but the effects were not additive. The time interval between successive ovipositions was not significantly affected by feeding time or temperature treatment. An exception was the shorter time interval between successive

TABLE 3. The influence of time of feeding and cyclic temperatures[1] on egg production, egg weight, egg specific gravity, and shell thickness of broiler breeder hens, Experiment 2

	Feeding time			
Variable	0700 h	1800 h	0700 h	1800 h
Eggs per hen[2]	13.93 ± 0.42^	15.19 ± 0.44*	14.78 ± 0.37*[b]	15.35 ± 0.38[a]
Egg weight, g	68.09 ± 0.96*	68.83 ± 0.98*	64.88 ± 0'.87^	65.19 ± 0.87"
Egg specific gravity	1.0838 ± 0.0009*	1.0837 ± 0.0009*	1.0793 ± 0i.0008[b]	1.0801 ± 0.0009[1']
Eggshell thickness, mm	0.3347 ± 0.005*[b]	0.3471 ± 0.005*	0.3239 i.004[b]	0.3349 ± 0.004*[b]
Op-op, h[3]	26.94 ± 0.32*	25.98 ± 0.33[b]	26.34 ± 0'.28[ab]	26.60 ± 0.29*[b]

*[b]Means ± SEM within a row with no common superscript differ significantly *($P < 0.05$).*

'LO = 10 to 25 C; HI = 21 to 39 C.

-Based on number of eggs produced per hen per 20-d period. Measurements of all other variables are based on 3-d period per week.

'Interval between two successive ovipositions, based on 7-d pretreatment and 9-d treatment period. Birds were watched every 15 min from 0700 to 300 h ever)' day.

TABLE 4. Estimated time for various stages of egg production in broiler breeder hens fed at 0700 and 1800 h and maintained under low (LO) or high (HI) cyclic temperatures, Experiment 2

Stage of egg formation	Temperature	Feeding time	Estimated time
			(h)
Oviposition-ovulation	LO	0700 h	<1.0
	LO	1800 h	<1.0
	HI	0700 h	<1.0
	HI	1800 h	<1.0
Oviposition-entry into shell gland	LO	0700 h	>6.5 but <7,0
	LO	1800 h	>6.5 but <7.0
	HI	0700 h	>6.5 but <7.0
	HI	1800 h	>6.5 but <7.0
Time in the shell gland[1]	LO	0700 h	20.19
	LO	1800 h	19.23
	HI	0700 h	19.59
	HI	1800 h	19.85
Oviposition-next oviposition	LO	0700 h	26.94 ± 0.32
	LO	1800 h	25.98 ± 0.33
	HI	0700 h	26.34 ± 0.28
	HI	1800 h	26.60 ± 0.29

Estimated as the difference between the time interval between two successive ovipositions and time of entry into the shell gland.

oviposition for hens at LO and fed their daily allowance in two meals (Experiment 1) or fed at 1800 h (Experiment 2). Wilson and Keeling (1991) concluded that feeding in the afternoon did not change oviposition time in dwarf broiler breeders, 34 wk of age, whereas it significantly increased the proportion of eggs laid in the afternoon in 65-wk-old Arbor Acres broiler breeder hens. Harms (1991), on the other hand, showed a slight change in the time of oviposition due to feeding 52- and 58-wk-old Arbor Acres broiler breeder hens at 1600 h. These observations were confirmed by our data. There was a significant change in time of oviposition due to feeding at 1800 h when the temperature treatment was ignored. Feeding time and cyclic temperatures did not affect time of oviposition of the first-of-sequence eggs; however, hens maintained under HI tended to lay a larger proportion of eggs at an earlier time compared to hens maintained under LO.

Nordstrom (1973) measured the duration of the egg formation in 18-mo-old Single Comb White Leghorn laying hens before (at a constant temperature of 21 C), and after hens were exposed to a constant temperature of 32 C for 3 wk. The time interval between successive eggs was longer (27.7 vs 25.6 h) when the hens were moved to the high temperature. The author demonstrated that the egg spends more time (1 to 2 h) in the shell gland in heat-stressed hens. The results of present experiment do not agree with those of Nordstrom (1973) in that the high cyclic temperature resulted in no effect on the time that the egg spent in the shell gland or on the mean time interval between successive eggs.

Previous reports indicate that eggs with specific gravity below 1.080 had the lowest hatchability (McDaniel *et ah,* 1979). Changing the time of feeding from 0700 to 1800 h had no significant effect on egg specific gravity (1.085 and 1.086 Experiment 1; 1.083 and 1.083, Experiment 2). At HI, egg specific gravity was 1.081 and 1.082 (Experiment 1) and 1.079 and 1.080 (Experiment 2) when feeding time was changed from 0700 to 1800 h. It is apparent that heat caused a significant reduction in eggshell quality. Because of the only slight nonsignificant changes in eggshell quality, changing the time of feeding from 0700 to 1800 h is not an effective procedure to improving eggshell quality in heat-stressed hens.

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