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The effect of feeding time on shell quality and oviposition time in broiler breeders

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Abstract 1. Three experiments were performed to determine the effect of feeding time on shell quality and oviposition time in broiler breeders.

2. Mean eggshell thickness was increased significantly by 3·5 μm (approximately 1%) per h delay in feeding time when hens were housed in individual cages. However, eggshell thickness was not significantly affected by feeding time when birds were housed on litter floors.

3. Mean oviposition time was delayed relative to lights on by 5 min per h delay in feeding time.

4. Egg weight was not significantly affected by feeding time, suggesting that differences in shell thickness and oviposition times were not due to increased oviducal transit times.

5. Producers who wish to implement delayed feeding may have to turn lights on earlier than usual to compensate for delayed oviposition times.

INTRODUCTION

Broiler breeders are usually given a limited daily allowance of feed in the morning. This practice does not supply nutrients to coincide with the hen's need, particularly for shell formation (Bootwalla *et al*., 1983), which normally commences in the afternoon or evening. This is because broiler breeders are unable to meter calcium (Ca) from the crop to the lower digestive tract at a uniform rate (Farmer *et al*., 1983*a*). It may be possible to improve eggshell quality if nutrients are supplied at times that correspond more closely to periods of shell deposition by changing the time of feed intake. Bootwalla *et al*. (1983), Farmer *et al*. (1983*b*), Brake (1988) and Harms (1991) reported increases in egg specific gravity when birds were fed later in the day. Lewis and Perry (1988) reported an increase in shell thickness and shell weight when broiler breeders were given half the daily food allocation twice daily compared to a single allocation of food provided in the morning. However, experiments performed by Brake (1985), Wilson and Keeling (1991), and Samara *et al*. (1996) showed no effect of feeding time on eggshell quality.

Although afternoon feeding of broiler breeders may improve shell quality, there is a potential concern, substantiated by subjective commercial observations (Lewis and Perry, 1988), that delaying feeding may delay oviposition. Such delays may cause egg collection problems in that a large proportion of eggs may be laid late in the afternoon or in the early evening, after the final egg collection of the day. Various researchers have attempted to determine whether changing the time of feeding alters oviposition time, with incongruous conclusions. Harms (1991) and Samara *et al*. (1996) reported a delay in the time of oviposition when broiler breeders were fed later in the day. A similar response was observed in cross-bred layers (Daniel and Balnave, 1981) and Japanese quail (Hassan *et al*., 2003). However, Brake (1985) reported no difference in oviposition times between morning- and afternoon-fed breeders. Lewis and Perry (1988) observed no difference in oviposition time between broiler breeders fed a single allocation of food in the morning or half the daily food allocation twice a day. Furthermore, Wilson and Keeling (1991) reported a delay in oviposition time due to afternoon feeding in standard sized broiler breeders, but observed no such response in dwarf breeders.

Because of these contradictions in the literature, three experiments were performed to determine the effect of feeding time on shell quality and oviposition time in broiler breeders.

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MATERIALS AND METHODS

In experiment 1, 432 24-week-old Cobb 500 broiler breeder females from an earlier trial were housed in individual cages in a closed house and subjected to a 14-h artificial photoperiod from 07:00 to 21:00 h. Six feeding treatments, each replicated twice, were applied to 32 weeks of age. The feeding treatments were different times at which birds were fed a daily allocation of 165 g of a commercial broiler breeder layer diet (139 g crude protein (CP)/kg, 12·2 MJ TME_N/kg, 33 g Ca/kg). The feeding times were 07:30, 09:30, 11:30, 13:30 or 15:30 h; there was also one treatment in which birds were given half the daily feed allocation at 07:30 and half at 15:30 h (half-feeding). The numbers of normal, soft-shelled, cracked and double-yolked eggs produced were recorded daily. Eggs were collected at half-hourly intervals between 06:00 and 21:00 h during two 2-d periods, at 28 and 31 weeks. Egg weight and shell thickness were determined from randomly selected normal eggs using 80 eggs per treatment at 28 weeks, and 40 eggs per treatment at 31 and 32 weeks.

In experiment 2, 800 57-week-old Cobb 500 broiler breeder females were housed on litter floor pens (50 per pen) in a curtain-sided house and subjected to a 14-h photoperiod from 05:00 to 19:00 h. The birds were given a single daily feed allocation of 150 g of a commercial broiler breeder layer diet (145 g CP/kg, 11·5 MJ TME_N/kg, 35 g Ca/kg) at 07:30, 10:00, 13:00 or 15:30 h, each represented in 4 pens. Eggs were collected hourly from 04:00 to 19:00 h during two 2-d periods, at 58 and 59 weeks. Egg weight and shell thickness were measured for all normal eggs laid on one day at 59 weeks of age.

In experiment 3, 240 35-week-old Cobb 500 broiler breeder females were housed in 60 individual cages in each of 4 light-tight rooms and subjected to a 16-h photoperiod from 07:00 to 23:00 h. Within each room, 15 birds were given 170 g of a commercial broiler breeder layer diet (150 g CP/kg, 11·6 MJ TME_N/kg, 26 g Ca/kg) daily at 07:30, 10:00, 13:00 or 15:30 h. Oviposition times were monitored from 06:00 to 21:00 h during three 2-d periods between 36 and 37 weeks. For each feeding time, and for each one-hour period between 10:00 and 16:00 h, egg weight and shell thickness measurements were taken from 5 randomly selected normal eggs, pooled from all 4 rooms.

In all cases, shell thickness was measured with a micrometer (Mitutoyo) at two points on the equator of each egg. Egg production data from experiment 1 were subjected to analysis of variance. In all three experiments, the effects of feeding time on egg weight, shell thickness and oviposition time were analysed using linear regression. Statistical analyses were performed using Genstat 6th edition (Lawes Agricultural Trust, 2002).

RESULTS AND DISCUSSION

Feeding time had no significant effect on total, broken and soft-shelled or double-yolked egg production from 26 to 32 weeks in experiment 1. A regression was performed on shell thickness data from experiments 1 and 3 with differences between trial means removed by fitting a constant to data from experiment 3 by least squares. The equation describing the regression was:

$$y = 380 + 3{\cdot}5\mathrm{F} \quad \left(P < 0{\cdot}001,\ r^2 = 0{\cdot}998,\ \text{slope SE} = 0{\cdot}17\right)$$

where y = shell thickness (μm) and F = feeding time (h after lights on), as shown in Figure 1. In experiment 1, the half-feeding treatment resulted in a mean shell thickness of 397 ± 34·6 μm which, according to the regression equation, corresponds to a single feeding at approximately 4·9 h after lights on. In experiment 2, no significant response of eggshell thickness to feeding time was observed (Figure 1). Egg weight was not significantly affected by feeding time in all three experiments.

The observed increase in eggshell thickness due to delayed feeding in experiments 1 and 3 is in agreement with other studies (Bootwalla *et al.*, 1983; Farmer *et al.*, 1983*b*; Brake, 1988; Harms, 1991). The absence of a significant difference in egg weight suggests that the improvement in shell thickness was not due to increased egg formation time but rather to improved calcium utilisation, as explained by Farmer *et al.* (1983*b*) and Roland and Farmer (1984). In morning-fed birds, a large proportion of ingested calcium passes through the digestive tract before the initiation of shell calcification (Farmer *et al.*, 1983*b*). Consequently, these hens would have had to store most of the calcium in the bone and, therefore, the route calcium took to the eggshell for morning-fed birds was via the small intestine to blood to bone to shell gland and eventually to shell. However, when feeding was delayed, the period of shell deposition was closer to the time of feeding, which would have resulted in afternoon-fed birds having a greater proportion of retained calcium in the gastrointestinal tract at the commencement of shell formation than morning-fed birds (Farmer *et al.*, 1983*b*). A negative correlation exists between bone mobilisation and eggshell weight (Sauveur and Mongin, 1983) and

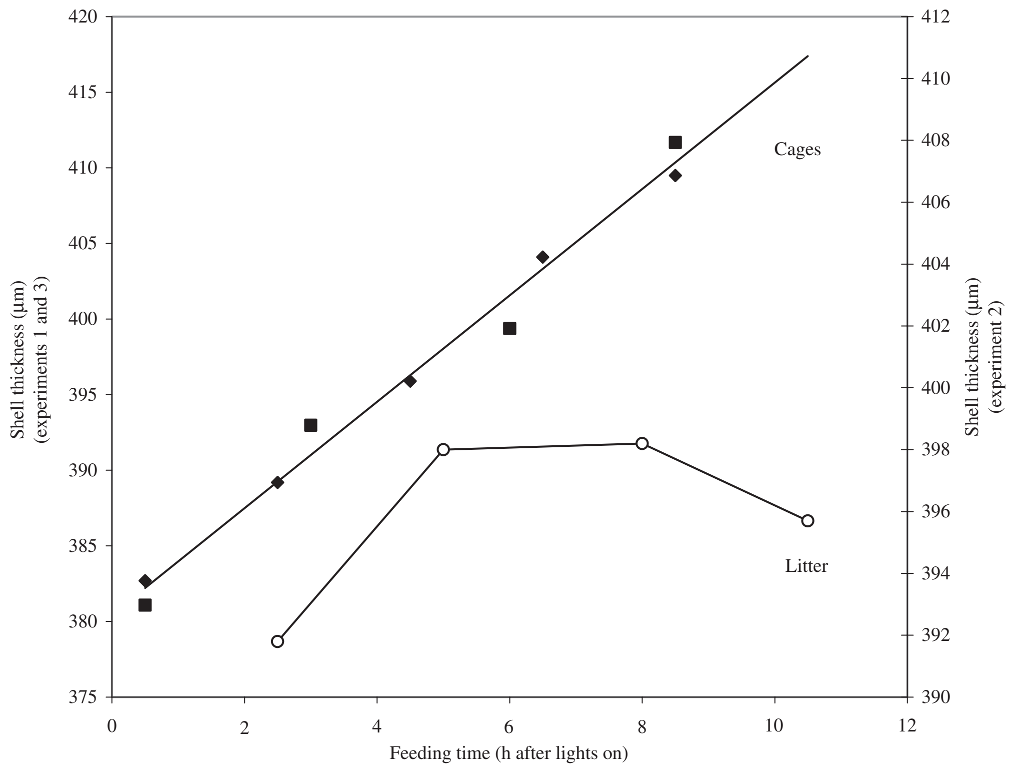

Figure 1. *The effect of delaying feeding on shell thickness of Cobb 500 broiler breeders housed in individual cages or in litter pens (◆, experiment 1; ○, experiment 2; ■, adjusted experiment 3).*

quality (Farmer *et al.*, 1986). Thus, delayed feeding improved shell thickness by allowing more calcium to bypass the bone and be deposited directly on the egg via the blood (Roland and Farmer, 1984).

The lack of response in shell thickness to feeding time in experiment 2 is in contrast with the findings of experiments 1 and 3, but in agreement with the results of Brake (1985) and Wilson and Keeling (1991). Differences between results of the three trials may be due to housing system. Harms *et al.* (1984) reported that the specific gravity of eggs from broiler breeder hens maintained on litter was significantly better than that from hens maintained on wire. However, when the hens on wire had access to litter from floor pens, the specific gravity of eggs was equal to that from hens on litter, this improvement in egg specific gravity probably being due to the intake of calcium contained in the litter. Therefore, the absence of an effect of feeding time on shell thickness in experiment 2, where hens were housed on litter floors, and in the experiments performed by Brake (1985) and Wilson and Keeling (1991), where birds were housed on litter and slats, may be due to recycling of nutrients, such as calcium, in the litter (Bootwalla *et al.*, 1983; Harms, 1991). Other factors may also play a role, such as competition for food resulting in hens on the same treatment having unequal food intakes. However, in spite of such factors, a number of floor-pen studies have yielded significant increases in eggshell quality due to delayed feeding times (Bootwalla *et al.*, 1983; Farmer *et al.*, 1983*b*; Brake, 1988; Harms, 1991).

A regression using data from all three experiments was performed to determine the response of mean oviposition time (MOT) to feeding time. Differences between trial means were removed by fitting constants to data from experiments 1 and 2 by least squares. The equation describing the regression was:

$$y = 5{\cdot}762 + 0{\cdot}0807F \quad \left(P < 0{\cdot}01, r^2 = 0{\cdot}687, \text{ slope SE} = 0{\cdot}0184\right)$$

where $y =$ MOT (h after lights on) and $F =$ feeding time (h after lights on). The half-feeding treatment in experiment 1 resulted in a MOT of $5{\cdot}52 \pm 0{\cdot}208$ h after lights on. It is important to consider the close proximity of the hens on the various treatments in all experiments. Oviposition times of later-fed birds may have been synchronised to some extent by stress resulting from the feeding of birds on earlier feeding treatments. The delay in MOT by $4{\cdot}8 \pm 1{\cdot}10$ min per h delay in feeding time (Figure 2) may thus be an underestimate of the effect of feeding time on oviposition time. Delays in oviposition times

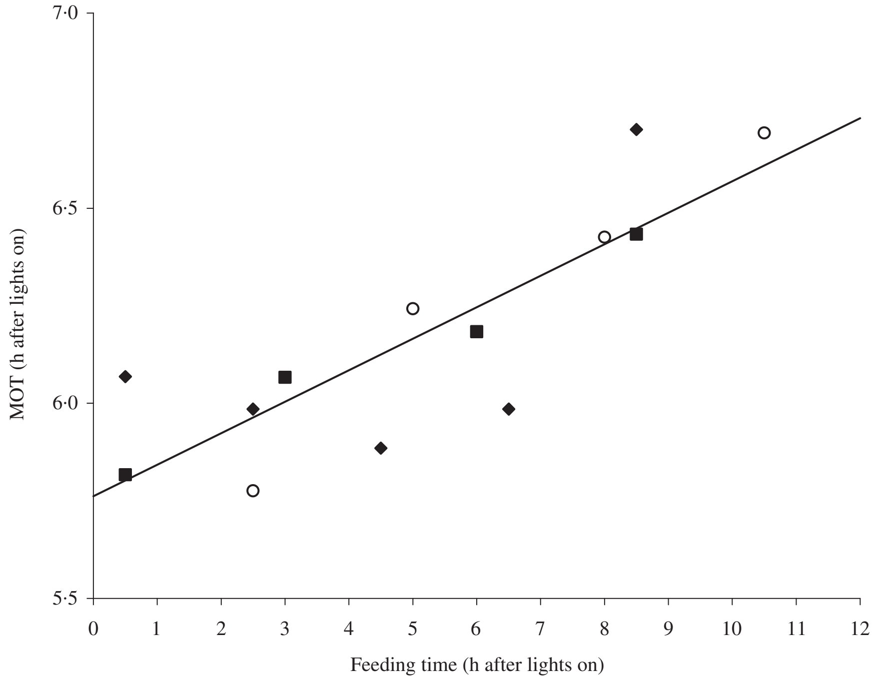

Figure 2. *Mean oviposition time (MOT) for Cobb 500 broiler breeders fed at various times relative to lights on (◆, adjusted experiment 1; ○, adjusted experiment 2; ■, experiment 3).*

may be greater than indicated in the current study when delayed feeding is employed in entirely separate houses. The lack of a significant difference in egg weight rules out the possibility that increased oviducal transit times may account for such differences in oviposition time and suggests that feeding time has some influence on the timing of the open period for LH release.

The results of these experiments suggest that the time of day when broiler breeders are fed influences shell thickness by altering the amount of readily available calcium in the digestive tract during shell calcification. Delaying feeding improves shell quality, although improvements may only be marginal in flocks that are housed on the floor. Delaying feeding results in delayed oviposition times, which may have unwanted consequences, such as eggs being laid later in the day. In order to prevent such problems, producers who wish to implement delayed feeding could turn lights on earlier in the morning to ensure that most eggs are laid before the final egg collection of the day.

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