Research Note: The effects of chick pipping location on broiler live performance

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ABSTRACT The objective of this study was to determine the effects of chick pipping location on live broiler performance. A total of 1,350 hatching eggs were collected from a commercial flock of Ross 308 at 38 wk of age. Eggs were incubated with either their large end up (**LEU**) or small end up (**SEU**). After transfer on d 19, the air cell area of each fertile egg was marked with a marker pen on the egg surface with a candling light and monitored every 6 h during the hatching period to accurately determine the location of the pip hole. Chicks were classified into 3 groups: 1) egg position LEU and pipped through the air cell (**LAC**); 2) egg position SEU and pipped through the air cell (**SAC**); and 3) egg position SEU and pipped through the small end of the egg, not through the air cell (**SSE**). Individual BW was recorded at placement and at 7, 21, and 35 d of age. Feed consumption was also determined at 7, 21, and 35 d of age. The feed conversion ratio (**FCR**) was calculated on a pen basis for the same time periods. Mortality was recorded twice a day, and percent mortality was calculated throughout the study. The European production efficiency index (**EPEI**) was also calculated.
All chicks that hatched from LEU eggs emerged from the egg at the region of the air cell; however, only 10.3% of chicks from the SEU position hatched through air cells. Pipping location greatly affected the hatch time. Chicks pipped through the air cell location hatched earlier than the chicks pipped without using air cell ($P < 0.001$). The initial BW at placement was higher in the LAC and SAC groups than in the SSE group ($P < 0.001$). This BW difference was still evident in the subsequent growing period, and the chicks that pipped the SSE exhibited a lower ($P = 0.059$) BW at 35 d. Additionally, the SSE group had a poorer FCR and numerically higher mortality than the other two groups at 35 d. Overall, the EPEI values in the LAC and SAC groups were higher than that in the SSE group at 35 d ($P < 0.001$). We concluded that broiler performance was negatively affected when the chicks pipped and hatched without using air cells.

Key words: egg position, pip location, air cell, hatch time, broiler performance

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INTRODUCTION

Hatching eggs are normally placed on setter trays with their large ends in the uppermost position followed by incubation in this position for 19 d. The embryo develops with its head towards the large end of the egg, right under the air cell, which is considered the optimum position for hatching (Tazawa and Whittow, 2000).

The gas in the air cell of fresh eggs has an oxygen content higher than that of atmospheric air (>21%). After a certain number of hours of incubation, this oxygen content falls to 19.5 to 20%. During the hatching period (18−20 d), the oxygen level in the air cell drops to 12 to 15%, and the carbon dioxide level reaches 4 to 7% until internal pipping (Romijn and Ross, 1938). At the time of internal pipping, an exceedingly high carbon dioxide content is present in the air cell (>9%), and the oxygen level falls to 9% or less (Visschedijk, 1968). In chick embryos, gas exchange takes place via the chorioallantoic membrane and the lungs approximately 24 h prior to hatching. Gas exchange by the chorioallantoic membrane starts to degenerate during the last phase of prenatal growth, and the embryos pierce their beaks into the air cell to start breathing the air cell gas via the lungs (Chiba et al., 2002). In addition, the carbon dioxide pressure in the air cell at the end of incubation stimulates the time of pipping (Visschedijk, 1968).

It is well documented that eggs incubated with their small end up (**SEU**) in setter trays show a decrease in hatchability compared to those with the large end up (**LEU**) (Takeshita and McDaniel, 1982; Bauer et al., 1990). However, some of the chicks pip and hatch without using the air cell after incubation in the SEU position (Bauer et al., 1990; Brand et al., 2011). To our knowledge, the effects of pipping either through air cell or not on

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broiler performance have not been investigated previously. Therefore, we aimed to investigate the effect of chick pipping location on subsequent live broiler performance.

MATERIALS AND METHODS

The experimental procedures used in these experiments were approved by the University of Ankara Institutional Animal Care and Use Committee (Ankara, Turkey).

Hatching Eggs and Incubation

Hatching eggs were collected from a commercial flock of Ross 308 at 38 wk of age and stored for 2 d at 17°C and 75% RH in a commercial hatchery (Beypilic, Bolu, Turkey). After storage, the eggs were transported to the poultry experimental facility of Ankara University (Ankara, Turkey) for 2 h in a climate-controlled vehicle. Thereafter, the location of the air cell of each egg was examined using a candling light, and eggs in which air cells were not located at the large end of the eggs were discarded. In this experiment, a total of 1,350 hatching eggs of approximately similar weight (63 ± 2 g) were randomly divided into 2 groups and incubated either with their LEU or SEU. In the LEU and SEU groups, 450 and 900 eggs were used, respectively. A larger number of eggs were set in the SEU treatment to compensate for the expected lower hatchability, thus ensuring a sufficient number of 1-day-old chicks. Half of the eggs from each group (225 and 450 eggs) were randomly set between 2 identical incubators, each with a capacity of 840 eggs (Cimuka Inc., Ankara, Turkey) to prevent possible adverse effects of minor machine variation. Eggshell temperature (**EST**) was measured twice each day by using an infrared digital thermometer (IRT 4520, Thermoscan, Braun, Germany) with a total of 20 marked eggs per machine during the incubation period. The incubator temperatures were programmed daily based on the EST. The EST was maintained at 37.8°C from 0 d to hatch in both machines. However, determination of EST was discontinued once the chicks began to hatch. The relative humidity was set to 55 ± 2% during the entire incubation process, and eggs were turned hourly by an angle of 45° until 19 d of incubation.

Pip Location and Hatch Time

Infertile eggs or eggs containing non-viable embryos were identified by candling and removed on d 19 (after 456 h of incubation), and fertile eggs were transferred to the hatching baskets, and hatching baskets were put back into the same incubators. The air cell area of each egg was marked with a marker pen on the egg surface by the use of a candling light and monitored every 6 h during the hatching period to accurately determine the location of the pip hole. Eggs were identified as pipping the shell either through air cells or not in both the LEU and SEU groups and then were placed in the same hatching baskets according to the pipping location. Chicks were classified into 3 groups: 1) egg position LEU and pipped through the air cell (**LAC**); 2) egg position SEU and pipped through the air cell (**SAC**); and 3) egg position SEU and pipped through the small end of the egg, not through the air cell (**SSE**). Chicks that pipped and hatched from the equator of the eggs (not through the air cell) were not used in the experiment.

Hatched chicks (closed navel and fairly dried) started to be counted from 468 to 510 h of incubation at regular 6 h intervals to calculate the average hatch time for each treatment group.

Broiler Grow-Out Management

The brooding facilities were preheated for 24 h before chick placement to achieve a stable and uniform litter temperature. At placement, the litter temperature was 33°C, which gradually decreased to 21°C by 21 d of age and remained at that level until 35 d of age. The chicks received 24 h of continuous light schedule (24 L:0 D), and the light intensity at the pen level was 25 lux during the growth period. Stocking density was 16 chicks per square meter. Chicks were fed a crumble form starter diet (3,000 kcal of ME/kg, 23% CP), and a pellet form grower diet (3,200 kcal ME/kg and 22.0% CP) was fed from 0 to 10 and 11 to 28 d, respectively. The pellet from the finisher diet (3.300 kcal ME/kg and 20.0% CP) was fed from 29 to 35 d. Both feed and water were available for ad libitum consumption, and diets were formulated to meet or exceed National Research Council (1994) recommendations throughout the grow-out period.

Broiler Performance Measurements

After completing the hatch process (510 h of incubation), the first grade chicks were feather sexed, counted, permanently identified with neck tags and weighed individually before being placed in a floor pen house on new wood shavings. Chicks from the LAC, SAC, and SSE groups were assigned to 14, 4, and 14 pens (1 × 1 m), respectively, each with 8 male and 8 female chicks for a total of 512 chicks. Individual BW was recorded at placement and at 7, 21, and 35 d of age. Feed consumption was calculated by the difference in feed offered and feed remaining on a pen basis at these days. The feed conversion ratio (**FCR**) was calculated based on feed intake divided by body weight gain on a pen basis. Mortality was recorded twice a day, and percent mortality was calculated throughout the study. The European production efficiency index (**EPEI**) was also calculated by the following formula:

$$\text{EPEI} = \frac{\text{BW (kg)} \times \text{ Liveability (\%)}}{\text{Production period length (d)} \times \text{ FCR}} \times 100$$

Statistical Analyses

A Z-test was employed to determine the existence of differences between 2 proportional values of average hatch time for the groups. Data on FCR and EPEI were analyzed using the GLM procedure of SAS, version 9.1 (SAS Institute Inc., Cary, NC) according to the following model: $Y_{ij} = \mu + PL_i + e_{ij}$, where μ is the overall mean, PL_i is the pip location (LAC, SAC, and SSE) and e_{ij} is the residual error term. Data concerning chick BWs were analyzed according to the following model: $Y_{ijk} = \mu + PL_i + sex_j + (PL \times sex)_{ij} + e_{ijk,}$ where PL_i is the pip location, sex_j is the sex of the chick, and $(PL \times sex)_{ij}$ is the interaction between pip location and sex. When the means of the GLM were significantly different, the means were compared using Duncan's test for multiple comparisons. The mortality percentage was analyzed using the chi-square test with Minitab Version 14 (Minitab Inc., United Kingdom). The statements of statistical significance were based on $P \leq 0.05$, unless otherwise indicated.

RESULTS AND DISCUSSION

Pip Location

In the current study, eggs incubated in the SEU position, 480 (68.8%) and 146 (20.9%) chicks hatched without pipping the air cell either at the small end or equator of the eggs, respectively. Only 72 (10.3%) chicks had pipped and hatched at the large end of the egg through the air cell. Among the eggs incubated in the LEU position, all chicks (416 chicks) pipped and hatched through the air cell. Similar to our results, Takeshita and McDaniel (1982) reported that eggs incubated in the SEU position pipped primarily in the small end, while those in the SEU position pipped primarily in the large end. However, Bauer et al. (1990) reported that 38.6% of embryos had pipped at the large end of the egg that had been incubated in the SEU position.

Hatch Time

The average hatch time differed among all treatments, with the earliest hatch time for the LAC group (483.8 h) followed by the SAC (487.1 h) and SSE (492.9 h) groups ($P < 0.001$). Chicks pipped through air cells at either the LEU or SEU position hatched earlier than the chicks pipped small end up (SSE), which could be linked to greater pipping to hatching intervals of SSE group (Takeshita and McDaniel, 1982). This may be related to the difference in the eggshell thickness of the pipping location. The shell is stronger on the small end of the eggs compared to the large end (Sun et al., 2012); therefore, the length of the pipping to hatch interval may be longer. Another possibility is that the high CO_2 level in the air cell may force the chick out as soon as possible (Visschedijk, 1968; Molenaar et al., 2010).

Broiler Performance

In the present study, the initial BW at placement (d 0) was higher in the LAC and SAC groups than in the SSE group ($P < 0.001$; Table 1). This BW difference between groups was evident during the subsequent growing period, and chicks that pipped the small end of the egg (SSE) exhibited a lower BW ($P = 0.059$) than groups that pipped through air cells incubated in either the LEU or SEU position at 35 d (Table 1). A similar trend was also found in a study reported by Takeshita and McDaniel (1982) in which the eggs in the SEU position produced lighter chicks than those in LEU until 19 d of incubation. It has been reported that late hatching chicks have a greater BW than early and middle hatching chicks at placement (Lamot et al., 2014; Özlü et al., 2018). In contrast, in our study, the average hatch times in the LAC and SAC groups were 9.1 and 5.8 h earlier than those in the SSE group, respectively, but the day-old chick weights were greater in both of the former groups than in the SSE group. It is possible that the embryos in the SSE group found moving their head difficult during the process of external pipping and spent more effort hatching than embryos that pipped through air cells. This may be the reason for the lower BW of the SSE group at placement.

There was no interaction ($P > 0.05$) between treatments and sex for BW, and as expected, males exhibited a higher BW than females after d 7 of age (data not shown; $P < 0.001$).

The effects of the pipping location on the FCR, mortality and EPEI is presented in Table 2. There was no significant difference in FCR among treatments for the first week, whereas the SSE group had a poorer FCR than the other two groups at 21 d ($P < 0.001$) with a similar trend at 35 d of age. The SSE group had numerically (2 times more) higher mortality than the other two groups at the end of the experiment. Bauer et al. (1990) conducted an experiment to determine the effect of egg position (SEU and LEU) on broiler performance and found no difference in broiler performance between the

Table 1. Body weight of broilers from placement time to 35 d of age according to egg position and pip location.

	Days of age			
Treatment[1]	0	7	21	35
	g			
LAC	43.5^{a}	196.4^{a}	1036.6^{x}	2307^{x}
SAC	43.1^{a}	195.5^{a}	1029.8^{x}	2297^{x}
SSE	42.6^{b}	189.0^{b}	1015.1^{y}	2257^{y}
SEM	0.15	1.08	6.56	14.7
P value				
Treatment	<0.001	<0.001	0.070	0.059
Sex	0.063	0.412	<0.001	<0.001
Treatment × Sex	0.330	0.247	0.532	0.509

[a,b] Means in a column with different superscripts differ significantly ($P \leq 0.05$).

[x,y] Means in a column with different superscripts differ significantly ($P \leq 0.07$).

[1] Egg position LEU pipped through the air cell (LAC); egg position SEU pipped through the air cell (SAC); and egg position SEU and pipped through the small end of the egg, not through the air cell (SSE).

Table 2. Feed conversion ratio (FCR), mortality, and European production efficiency index (EPEI) of broilers at 35 d of age according to egg position and pip location.

	FCR			Mortality			EPEI
	Days of age						
Treatment[1]	7	21	35	7	21	35	35
	g/g			%			
LAC	1.135	1.316^{b}	1.596	0.89	2.68	3.57	406.7^{a}
SAC	1.117	1.312^{b}	1.600	0.00	0.00	3.13	404.6^{a}
SSE	1.142	1.343^{a}	1.622	1.34	4.91	6.70	378.1^{b}
SEM	0.0115	0.0043	0.0088				4.31
P value	0.482	<0.001	0.096	0.352	0.090	0.168	<0.001

^{a,b}Means in a column with different superscripts differ significantly ($P \leq 0.05$).

[1] Egg position LEU and pipped through the air cell (LAC); egg position SEU and pipped through the air cell (SAC); and egg position SEU and pipped through the small end of the egg, not through the air cell (SSE).

groups at 42 d of age. However, in that study, there was high mortality in the LEU group over 7 d, which might affect the performance in the subsequent growing period.

On about d 19, when the chick penetrates the air cell (internal pipping) with its beak, the onset of breathing starts and the chorioallantoic and lungs are both functional (Rahn et al., 1979). In this study, the post-hatch performance was adversely affected in chicks hatched without using air cell (SSE group) may be explained by the delay in the onset of lungs respiration.

In the current study, the EPEI in the LAC, SAC, and SSE groups was 406.7, 404.6, and 378.1, respectively, at 35 d of age, and the EPEI in the SSE group was lower than that pipped through air cell incubated in either the LEU or SEU position at 35 d ($P < 0.001$). This study demonstrated that broiler performance was negatively affected when the chicks pipped and hatched without using air cell.

DISCLOSURES

All authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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