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Original Research Article

The Effects of Eggshell Temperature Manipulations (Intermittent Vs. Constant) During The Hatching Period on Broiler Final Performance and Slaughter Yield

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ABSTRACT

This study was carried out to determine the effects of eggshell temperatures during the hatching period on incubation results and broiler performance. A total of 1800 eggs with an average of 55-65 g was obtained from 42 weeks of broiler breeder flock. The eggs were randomly divided into three groups for temperature applications and placed in an incubator with the same conditions as 37,2°C temperature and 54% relative humidity during the first 18 days of incubation. After transfer to the hatcher, three different temperature manipulations were applied between 19 and 21 days of incubation: 1- Control group: (36,8-37,0˚C), 2- Intermittent; high-temperature application for 3 hours daily (38,8 - 39,0°C), 3- Constant; continuously high-temperature application (38,8 - 39,0˚C). On hatching day, the chicks were weighed individually. To determine the effects of temperature manipulations during the hatching period on broiler performance, the chicks were reared under the same conditions. At the end of the experiment, body weight and body weight gain were found to be significant (P<0.001). A higher body weight and body weight gain were found in the control group (2709.8 g and 2665.3 g) respectively. Also, the feed conversion ratio was calculated as 1.78, 2.05, and 2.13 in the control, intermittent eggshell temperature, and constant eggshell temperature manipulation groups, respectively (P<0.01). In the comparison of slaughter weight and carcass weight, a total of 20 broilers (10 male/10 female) from each group were randomly slaughtered. There was no significant difference between the groups for slaughter weight and carcass weight (P>0.05).

Keywords: Broiler, eggshell temperature, growth performance, slaughter

INTRODUCTION

Today, broiler chicken farming serves as an integrated sector that utilizes modern systems, including hatcheries, feed factories, production facilities, and slaughterhouses. In the 2000s, there was a rapid increase in production-related investments and the number of integrated facilities in the sector. Furthermore, European and global standards began to be implemented in broiler chicken production (Çakı 2007). A significant portion of the genetic material needed in the poultry sector is supplied through imports in many countries. In order to meet the continually growing demand for chicken meat, imports of breeding materials are increasing each year. Producing the maximum number of healthy and high-quality chicks during a production cycle from these imported breeders, which requires significant resources, is a crucial issue for both hatcheries and broiler chicken breeders.

The key to achieving high performance by obtaining the maximum number of uniformly sized, healthy chicks in hatcheries depends on providing optimal incubation conditions and producing quality hatching eggs. One of the most critical factors in incubation is temperature, with the recommended range being 37.5-37.7°C during the first 18 days of development and 36.1-37.2°C during the hatching period between 19-21 days. Since incubation temperature, specifically the temperature of the eggshell, serves as an indicator of the embryo's temperature, it is crucial to carefully monitor the shell temperature throughout incubation.

Embryos derived from high-yield genotypes, which are commonly used today, are highly sensitive to temperature fluctuations. Even small deviations in incubation temperature can significantly impact hatchability and chick quality (Lourens 2003). Fluctuations in shell temperature hold economic importance as they have a negative effect on broiler post-emergence performance and slaughter results (Wilson 1991; Lourens and Van Middelkoop 2000). Because abnormal incubation temperatures have a detrimental effect on organ development

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and post-hatch growth in birds, as supported by studies conducted by (Michels *et al*. 1974; Decuypere 1979; Geers *et al*. 1983; Joseph *et al*. 2006 and Hulet *et al*. 2007).

In hatcheries operating with large capacities, maintaining optimal temperatures becomes challenging due to the increased heat production of embryos, particularly during the second period of incubation (Nichellmann *et al*. 1998). Compared to twenty years ago, the eggs used today generate twice as much heat during the final stages of incubation, leading to the occurrence of overheating in the embryos. Therefore, the aim of the research was to investigate the effects of different temperature applications (intermittent vs. constant) during the hatching period on broiler final performance and slaughter yield.

MATERIALS AND METHODS

A total of 1,800 eggs weighing 55-65 g obtained from a 42-week-old breeding flock were used in the study. These eggs were stored at 16-18°C and 60-65% relative humidity for 3 days. The hatching eggs were randomly placed in a total of 30 trays, with each tray consisting of 60 eggs. Each tray was weighed and placed in three programmable, fully automatic and calibrated incubators (Çimuka, Ankara, Türkiye, 640 egg capacity). The eggs in all three incubators were provided with similar incubation conditions, including 37.2°C temperature and 55% relative humidity during the first 18 days of incubation period. On the 18^{th} day of incubation, the eggs were weighed to determine the egg transfer weight and then transferred to the hatchers.

Three different eggshell temperature manipulations were applied indicated according to the eggshell temperature (EST) treatments as given below:

1. Control treatment group: 36.8-37.0°C (Control EST)
2. High temperature treatment group for 3 hours a day: 38.8-39.0°C (Intermittent EST)
3. Continuous high temperature treatment group: 38.8-39.0°C (Constant EST)

After completion of hatching process, all of the hatched chicks in each experimental group were weighed using a scale with a ± 0.1 g precision to determine their hatch weight. Chicks obtained from three different experimental groups were weighed and then placed in 18 pens, with 40 chicks (20 males/20 females) in each pen and 6 replicates for each temperature treatment group. The experimental pens (with a size of 1.5 x 1.5 meters) were covered with wood shavings as a litter material, with a height of 10-15 cm. Throughout the experimental period, chicks were provided with ad libitum water and feed. The broilers were provided with four different commercial feeds: starter feed (between 1-10 days 23% CP, 3100 kcal/kg ME), grower feed (between 11-21 days, 22% CP, 3150 kcal/kg ME), finisher feed (between 22-36 days, 20% CP, 3200 kcal/kg ME), and pre-slaughter feed (between 37-42 days, 18% CP, 3,100 kcal/kg ME). The lighting schedule was applied as 24 hours of continuous lighting for the first 3 days, followed by 23 hours of light and 1 hour of darkness. During the first week, the chicks were kept at a temperature of 32-33°C and a relative humidity of 60-65%. After the first week, the temperature was reduced by 3°C each week, and from the 4^{th} week onwards, the chicks were kept under temperature conditions of 20-22°C and a relative humidity of 50-60%.

Throughout the experiment, the amount of feed given to each pen and the mortality were recorded daily. Body weight gain was monitored by pen based weightings using a precise scale with an accuracy of ±0.1 g. According to the obtained data, final body weight, body weight gain and feed conversion rate (FCR) were calculated for each experimental group. At 42 days of age, 20 broilers (10 males/10 females) were randomly selected and weighed from each experimental group to determine the slaughter weight, carcass weight, and slaughter yield of broilers. The broilers were subjected to 12 hours feed withdrawal period prior to slaughter process. After cooling process of carcasses, the carcass was determined by weighing of each carcass.

The care and use of animals were in accordance with the laws and regulations of Türkiye and approved by the Ethical Committee of the Bursa Uludağ University (License number 2013-15/01).

Statistical Analysis

The statistical analysis was performed using Minitab 16 package program. One way Anova variance analysis was applied to all the data. In case of differences between group means, the Tukey test was used to compare their means. In all cases, a probability of P < 0.05 was considered significant. Data are given as the means ± standard errors in the table.

RESULTS AND DISCUSSION

Body weight (day 1 and day 42) and body weight gain (between day 1 and 42) of broilers obtained by different eggshell temperature manipulations during hatching period is given on Figure 1. As seen in the figure, a higher chick weight was observed in the control EST and intermittent EST groups compared to the constant EST group (P<0.001). At the end of the experiment, a higher body weight and body weight gain were found in the control group (2709.8 g and 2665.3 g respectively, P<0.01). These results are consistent with the findings of Meijerhof (2009), who stated in their study that chick development is inadequate under poor incubation conditions and it affects the chick hatch weight on the hatching day. Similar findings have also been reported by (Joseph *et al*. 2006; Leksrisompong *et al*. 2007; and Molenaar *et al*. 2010). In their study, Molenaar *et al*. (2011) found that the hatch weight of chicks was 40.6 g in the control group and 37.2 g in the high-temperature group.

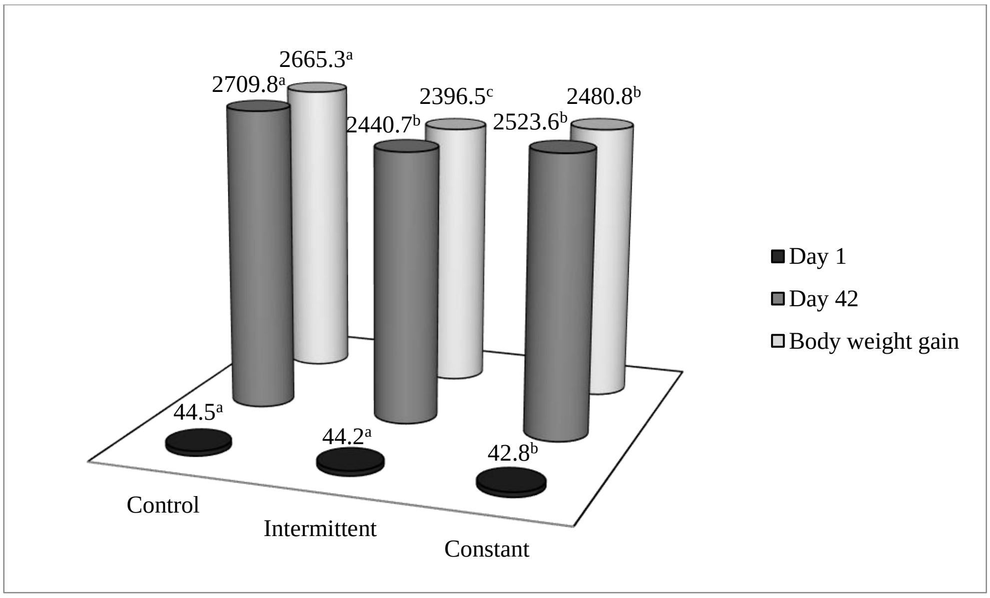

Figure 1. Body weight (day 1 and day 42) and body weight gain (between day 1 and 42) of broilers obtained by different EST manipulations during hatching period

At 42 days of age, the FCR was calculated as 1.78, 2.05, and 2.13 in the control, intermittent EST and constant EST manipulation groups, respectively (P<0.01). The study found that cumulative feed consumption in the high temperature group totaled 5,375.2 g, exceeding that of the other groups. Consequently, it was observed that the feed utilization rate in the control group was lower than in the other groups by the 6^{th} week of the feeding period. The feed conversion ratios were calculated as 1.93, 2.14, and 2.22 for the control, high temperature for three hours a day, and high temperature respectively. Another study, conducted by Hulet *et al*. (2007), further supports the notion that high temperatures influence feed conversion rates, aligning with the findings of this research. Hulet *et al*. (2007) divided the growing period into two phases: days 1-21 and days 22-35, noting that the feed conversion ratio varied between groups on days 36-44. However, they reported no significant difference in feed conversion ratio between groups during both individual days and the entire period (days 1-44).

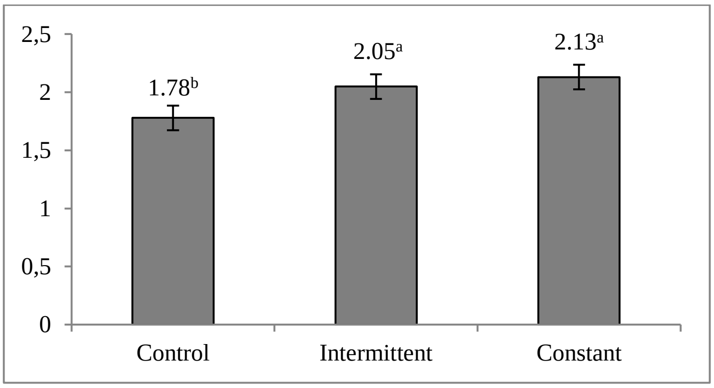

Figure 2. Mean FCR values of broilers obtained by the different EST manipulations during hatching period

The comparison of slaughter yield of broilers obtained by different EST manipulations during hatching period was given in Table 1. The slaughter weight and carcass weight of broilers was found to be similar among the treatment groups (P>0.05).

High temperatures during the incubation period have been associated with adverse effects on broiler performance and slaughter efficiency, leading to economic losses (Lourens and Middelkoop 2000; Hulet *et al*. 2007) investigated the impact of high-temperature treatments at 37.5°C, 38.6°C, and 39.7°C on broiler performance and slaughter efficiency commencing from the 16th day of incubation. In the study, the weights of chicks obtained from high temperature applications of 37.5°C, 38.6°C, and 39.7°C on the first day were recorded as 41.1 g, 42.2 g, and 43.1 g, respectively. On the 44th day, their weights were measured as 2,213 g, 2,263.3 g, and 2,165.7 g, respectively. In the study, it was found that on the first day after placing the chicks in the farm, the chick weight in the control group and the groups exposed to high temperature for three hours was approximately 1.5 g higher than in the continuous high temperature group. The control group exhibited the highest live weight among the treatment groups on days 7, 14, 21, and 28 of the rearing periods.

In the study, higher live weight values were observed on the 35th and 42nd day in both the control and high temperature groups. These findings echo those of Molenaar *et al*. (2011), which strengthens the study's conclusions. Molenaar *et al*. (2011) found that broiler chickens in the control group consistently outweighed those in the high temperature group throughout the growing period. Initial weights were 41 g and 38 g in the control and high temperature groups, respectively, while on the 42nd day, live weights were 2,895 g and 2,854 g, respectively. However, contrary to these results, some studies, such as those by Joseph (2004) and Joseph *et al*. (2006), have suggested that high temperatures do not impact broiler live weight during the growing period. Joseph *et al*. (2006) specifically investigated the effects of a 38.1°C control temperature and a 39.4°C high temperature during an incubation period of 19-21 days. They explored hatching outcomes, broiler performance, and slaughter efficiency, noting that live weight and live weight gain, a measure of broiler performance, were comparable between both temperature groups.

In their study, Hulet *et al*. (2007) reported slaughter weights of broiler chickens obtained under high-temperature applications of 37.5°C, 38.6°C, and 39.7°C as 2,136.7 g, 2,176.6 g, and 2,095.1 g, respectively. Similarly, carcass weights were determined as 1,598.4 g, 1,601.1 g, and 1,545.7 g for the respective temperature treatments. Furthermore, no significant differences were observed between groups in terms of carcass part weights. Breast weights from carcasses obtained under high-temperature treatments of 37.5°C, 38.6°C, and 39.7°C were determined as 344.3 g, 356.3 g, and 347.2 g, respectively, while thigh weights were 290.1 g, 289.9 g, and 282 g, respectively.

Table 1. Slaughter yield of broilers obtained by the different EST manipulations during hatching period

Features	Control	Intermittent	Constant	P- Value
Slaughter weight	2678 ± 326.1	2528.5 ± 246.6	2528 ± 262.6	0.159
Carcass weight	1665.5 ± 224,1	1565,5 ± 180,3	1590,5 ± 195,2	0.269

n: 20 chickens / temperature application group

CONCLUSIONS

As a result, successful hatching practices are crucial for both hatchability and chick quality. Hatcheries strive to maximize the number of marketable chicks, while broiler chicken breeders aim to commence the breeding period with high-quality, healthy chicks. The study revealed that high temperatures applied for varying durations during the hatching period had adverse effects on the rate of marketable and discarded chicks, as well as on incubation parameters, particularly chick hatching weight, and broiler chicken performance during the fattening period. Maintaining optimal incubation temperatures and vigilantly monitoring temperature settings during incubation facilitate uniform chick hatching and prevent excessive dehydration of chicks remaining in the incubator post-hatching. Consequently, incubator temperature management emerges as a critical factor influencing the profitability and efficiency of both hatcheries and broiler breeders.

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