Scientific Papers. Series D. Animal Science. Vol. LXVII, No. 1, 2024
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EFFECT OF DIFFERENT COLOR LED LIGHTING IN INCUBATION ON HATCHING PERFORMANCE

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Abstract

Three different LED light colors were applied during Gerze local Turkish chicken egg incubation. Red, green, and white colors were used each containing 160 eggs for 18 days. Eggs were individually weighed at the onset of incubation and during transfer to the hatchery. Lighting was not applied in the hatchery and chicks were hatched in darkness. Total egg weight loss of incubation was 10.45%, 9.43% and 8.90% for red, green, and white led groups and the differences were significant (P<0.05). Fertility between light-color groups was insignificant. The red light group had the highest hatchability (82.64%) in fertile eggs, while the green and white groups had 81.72% and 67.67% respectively. While the egg weight differences between light groups were insignificant; the highest chick weight was obtained in the green light group (P<0.05). The white LED color delayed the hatching time of the chicks. All hatched chicks were scored according to Pasgar Scoring. The scores of chicks were 9.68, 9.62, and 9.71 for the red, green, and white lighting groups' chicks.

Key words: *Gerze chicken, incubation, LED lighting, Pasgar Score.*

INTRODUCTION

The incubation is one the most important steps of poultry production and the main goal of incubators is to get healthy and strong chicks (Scripnic & Dreahlo, 2016). The environment during incubation has a permanent effect on the health and welfare of chickens after hatching. (Archer et al., 2009). Temperature, humidity, air composition in the cabin and turning of the eggs are major environment components of the incubation. Also, other factors like, the age and nutrition of breeders, eggshell thickness (Yamak et al., 2015), and storage condition of eggs (Yamak et al., 2023) could affect hatching traits. Light is an important exogenous factor for controlling many physiological and behavioural processes in animals (Li et al., 2021). It is also reported that providing light during incubation could affect hatchability. Hatchability (Archer et al., 2017), embryonic growth (Zhang et al., 2016), hatching time (Shafey & Almohsen, 2002), feed conversion (Zhang et al., 2012) and 1behaviour after hatching (Archer et al., 2017) are affected by lighting during incubation. It is reported that lighting during incubation was helpful for chicks to adapt to the new environment after hatching (Ozkan et al., 2012). The hatch window is the duration between the first hatched and last hatched chicks in incubation. The aim of the hatcheries is to shorten the hatch window (Calik et al., 2023). The effect of providing lighting during incubation on the hatch window has not been investigated widely before. The effect of hatching time on chick quality is determined by scoring chicks at the end of hatching. Using lighting during the incubation had some difficulties like increasing the inside temperature of the cabins. However new lighting techniques i.e., light-emitting diode (LED), made the use of light sources more practical, without affecting inside temperature (Yameen et al., 2020). In this study, red, green, and white LED lighting was applied during incubation of Turkish native Gerze chicken eggs. Hatching traits and chick quality of the eggs according to lighting colors were investigated in the study.

MATERIALS AND METHODS

This study was conducted at the Ondokuz Mayis University Experimental Farm Hatchery Unit. A total of 480 eggs were collected from Gerze flock of the farm for 4 days. All eggs were kept

in a storage machine set at 18°C and 70% relative humidity. After storage; eggs were individually numbered, weighed and divided into three groups each containing 160 eggs. Each group had two replicates with trays 80 eggs. The incubation machine had 10 tiers. The LED lightings were placed in three different tiers by separating each from the others by black curtains to prevent light transmittance.

Incubation

Eggs were placed in the incubator, which was set to 37.7°C and 60% relative humidity. On day 18 (432 hours) eggs were transferred to hatching machine which was set to 37.5°C and 70% relative humidity. At transfer, all eggs were individually weighed to calculate egg weight loss during incubation. No lighting provided in hatching machine. 24 hours after egg transfer (456 hours) all hatching baskets were checked to count hatched chicks at 6 hour intervals. All unhatched eggs were individually broken to determine fertility and embryonic mortality after incubation was completed. The fertility, hatchability of fertile eggs, and hatchability were calculated as follows:

Fertility: number of fertile eggs/total number of eggs

Hatchability of fertile eggs: number of hatched chicks/number of fertile eggs

Hatchability: number of hatched chicks/total number of eggs

Chick quality

The Pasgar©Score method was used to determine chick quality. After hatching, all chicks were scored individually according to the method described by Boerjan (2006). The Pasgar©Score is based on the chicks' reflex as a measure of activity and the appearance of the navel, legs, beak and absorption of the yolk sac. A top quality keet has a score of 10, with 1 point being subtracted for each abnormality recorded in one of the five aforementioned criteria.

Statistical Analyses

The normal distribution of the data was analyzed with the Shapiro-Wilk test. The results indicate that the data were normally distributed ($P > 0.05$). The homogeneity of variances was analyzed using the Levene test. The result showed that the variances were homogeneous ($P > 0.05$). Data analysis was performed with the one-way analysis of variance (ANOVA), while the comparison of means was analyzed using Duncan's multiple comparison test. SPSS 21 software was used with an OMU license.

RESULTS AND DISCUSSIONS

The egg weight, egg weight loss ratios, fertility, hatchability of fertile eggs, total hatchability, chick weight and Pasgar scores of chick for red, green and white lighting groups were given in Table 1. The weights of eggs in lighting groups were 47.46 g, 47.49 g and 47.04 g for red, green and white colors, respectively. The weight of eggs was in parallel with the findings of Arslan et al. (2023) who reported the egg weight 48.32 g for Gerze chickens. The differences between egg weights were insignificant. This was an expected result of collecting the eggs from same flock. The egg weight loss ratios were significantly differed between lighting groups ($P<0.05$). Highest egg weight loss occurred in red lighting group (10.45%), while green and white light provided groups lost 9.43% and 8.90% of weights, respectively. Eggs have to lost 11.5-12% of their weights during incubation (Tona et al., 2001). This is also important for chick quality and success of the incubation. Similar to our findings, Li et al. (2021) determined relatively higher egg weight loss in the eggs provided red lighting during incubation, but the differences were not significant. Hatchability of fertile eggs was significantly higher in red and green lighted eggs than white lighted eggs. It is previously reported that lighted incubation positively affects hatchability of eggs. Ghatpande et al. (1995) attributed this increase to acceleration of embryonic development by light. Hluchý et al. (2012) had similar findings to this present study with red light increasing hatchability. Contrary to our results, Archer (2017) reported that white light and monochromatic red light increased the hatchability when compared with the dark incubated eggs. Also, Archer (2015) remarked the red light is the success key of hatchability for eggs. The lower hatchability of white lighted group could be related to egg shell colours of Gerze chickens. They lay white eggs. Huth & Archer (2015) reported that increased hatchability could be related to the light

spectrum passes through the eggshell. Also, it has been defined that only 1% of the light reaches the embryo (Shafey et al., 2005). We thought that the ratio could be less in white light-white shell match-up. The total hatchability of eggs had similar results to the hatchability of fertile eggs. This is mostly about the fertility-hatchability relation. While the differences between the fertility of lighting groups were not significant, the effect of lower hatchability of fertile eggs caused lower total hatchability in the white lighted egg group.

Table 1. Hatching traits of eggs incubated with different LED lighting colours

Specification	Red	Green	White
Fertility (%)	93.75	95.00	91.87
Hatchability of fertile eggs (%)	82.64[a]	81.72[a]	67.67[b]
Total hatchability (%)	77.50[a]	77.50[a]	61.88[b]
Egg weight loss (%)	10.45[a]	9.43[b]	8.90[c]
Egg weight (grams)	47.46	47.49	47.04
Chick weight (grams)	29.93[b]	32.16[a]	29.35[b]
Pasgar Scores of chicks	9.68	9.62	9.71

a, b, c: Differences in the same lines are significant; P<0.05

The mean chick weight at hatch was significantly higher in green lighted group eggs. When light exposure was continuous an increased overall embryo weight as well as embryo muscle weight was also found by Wang et al. (2014). But Li et al. (2021) reported that muscle growth may depend on light exposure, but was not only associated with circadian rhythms entrained by photoperiod. Besides light exposure, light wavelength and intensity can influence the amount of light that can pass through the eggshell and reach the embryo (Li et al., 2021). Similar to our findings, Zhang et al. (2014) showed that using green light during incubation results in higher chick weight at hatch by enhancing proliferation and differentiation of skeletal muscle satellite cells in the late embryonic stage and newly hatched chicks. Yu et al. (2018) found green LED light at low intensity (50 lux) stimulated embryo growth during incubation, but no improvement in the embryo when the green light was set to 150 or 300 lux. These results indicate that light intensity could have a strong effect on embryo development.

Hatching distributions of the chicks are shown in Figure 1. Hatching started at 456 hours of incubation and ended at 522 hours in the eggs incubated with red lighting. Hatch window was calculated as 66 hours. In green lighted group, hatching started at 462 hours and completed at 522 hours. Hatch window of green lighted group was calculated as 60 hours.

Conversely to red and green lighted group, eggs provided white light during incubation had a delayed hatching performance. The hatching of the eggs started at 546 hours of incubation and completed at 576 hours with 30 hours hatch window. The reason of this delaying is unclear. Although Tang et al. (2023) reported a postponement in the hatching of eggs incubated with green and white lights, the delay in our study is much longer and could not explained. Another reason for the delay could be related to temperature fluctuations, particularly in the hatching machine. Further studies need to investigate the effects of higher light intensities on hatching time. Chick quality is determined by Pasgar scoring in the current study. There was not a significant difference between the scores of lighting groups.

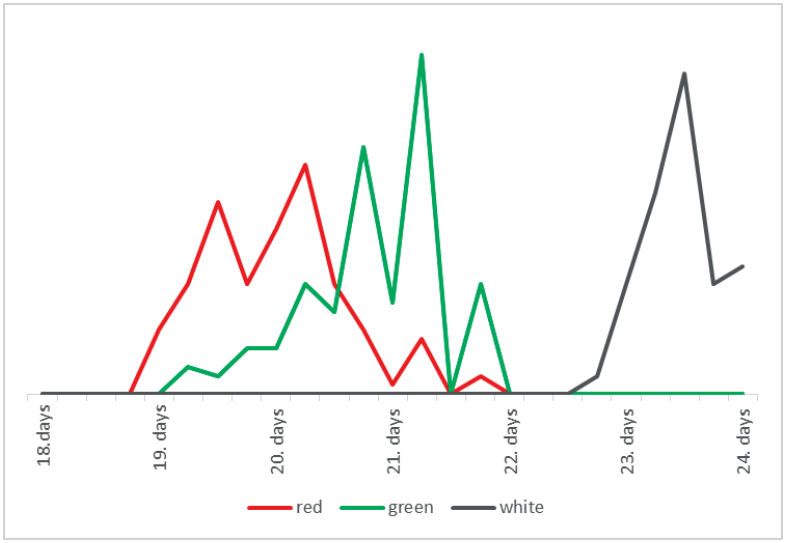

Figure 1. Hatching spread of chicks according to lighting groups

CONCLUSIONS

In conclusion, providing red and green LED lighting during incubation improved the hatchability of eggs while causing a delay in white lighting which resulted in significantly lower hatchability in this group. The chick weight in the green lighted group was significantly higher.

ACKNOWLEDGMENTS

This study was supported by Scientific and Technological Research Council of Turkey (Project number: 123O808)

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