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Effects of High Incubation Temperature on the Body Weight and Yolk Consumption of Two Commercial Broiler Strain*

Tugba Ozaydın & Ilhami Celik

ABSTRACT

***Background*:** Temperature is the most important factor controlling embryonic development. Hyper- and hypothermic effects depend on the degree of temperature, duration of exposure and the stage of the development. From the middle of incubation period, embryo temperature is greater than air temperature of the incubator because of the increased metabolic activity. Thus elevated temperature especially in the second half of incubation has a major impact on hatchability and chick quality. The aim of this work was to investigate and compare the effects of high incubation temperature applied from the 10th day to the end of incubation on the body weight and yolk consumption of Ross 308 and Hybro embryos.

***Materials, Methods & Results*:** In the experiment, a total of 500 eggs, 250 fertile eggs from each of Hybro and Ross 308 broiler strains were used. The eggs of each strain were weighed and then divided into 2 groups as control and high incubation temperature exposed (heat-stress) groups. The control eggs of both strains were maintained under optimal conditions (incubation temperature: 37.8°C) during the whole incubation period, whereas heat stress imposed eggs were maintained under 37.8°C until the 10th day of incubation and then continuously exposed to high temperature (38.8°C) in the incubator. Other environmental conditions were standardized. At the 11, 13, 15, 18, 20 and 21st days of incubation, randomly sampled eggs from each group were opened until 10 living embryos were obtained from each group. The embryos and their yolk sacs were weighted at the 11, 13, 15, 18 and 20th of incubation and chick weight with yolk sac were determined on hatching day (d 21 of incubation) of the groups. Mean relative embryo weights [(embryo weight/egg weight at setting) x 100] and relative yolk sac weights [(yolk sac weight/egg weight at setting) x 100] of each groups were calculated. In both strain, the heat stress group had a significantly lower yolk-free embryo weight than the control group. However relative yolk weights in heat-stress groups were found to be significantly higher when compared to those in the control groups. There was no significant difference between mean embryo and yolk sac weights of the control groups both strains, except for embryo weight at 20th d of incubation. We also observed that the chicks were heavier at the day of hatch in heat-stress groups than the control groups.

***Discussion*:** These observations suggest that high incubation temperature (38.8°C) from the 10th of incubation decreased yolk consumption and depressed mean embryonic weights. Maternal antibodies are passively transferred from the hen to the offspring through the yolk and albumin. Therefore decreased consumption of the yolk due to high incubation temperature will not only affect the body weight, but may also negatively affect the immune status of the newly hatched chick. We also observed that body weight of the chicks at the hatch day was higher in the heat-stress group of both strains in comparison to their controls. Greater amounts of remaining of unused yolk in the heat-stress groups may be responsible for this difference. Results of the present study have revealed that the efforts to increase the body weight of broilers should not be limited to management and care at post hatch period, incubation factors affecting the performance should be determined and taken necessary precautions.

Keywords: high incubation temperature, body weight, yolk consumption, broiler embryo.

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*Article based on a Thesis submitted by the senior author in partial fulfillment of requirements for the Doctor's Degree. Department of Histology and Embryology, Faculty of Veterinary Medicine, University of Selcuk, Campus, Konya, Turkey. CORRESPONDENCE: T. Ozaydın [ttelatar@selcuk.edu.tr - FAX: +90 (332) 2410063]. Department of Histology and Embryology, Faculty of Veterinary Medicine, University of Selcuk, Campus Konya. Konya 42075 Turkey.

INTRODUCTION

Embryonic development is a dynamic process, which is affected by not only the genetic background of the organism, but also many factors in the microenvironment around the egg [4,18]. The incubation temperature is the most important environmental factor that affects embryonic development. Thus, it is essential to determine and use the optimum temperature that achieves the highest hatchability and the best hatchling quality. The optimum incubation temperature is 37.8ºC for broiler embryos [11].

Hyper- and hypothermic effects depend largely upon the degree of temperature, duration of exposure and embryonic age [20]. Several studies have been conducted to elucidate the effects of different temperature manipulations and exposure duration on hatchability and chick quality, with variable results [2,9,10,12,13,19]. Additionally temperature manipulation during embryogenesis is currently being studied as a tool in order to improve thermotolerance acquisition [3,16]. The aim of this work was to investigate the effects of high incubation temperature applied continuously from the 10th day of incubation on the body weight and yolk consumption of embryos. Because the strain and line affect the tolerance to deviations from the optimum temperature during incubation [5], we also compared the effects of high incubation temperature on the body weight and yolk consumption of the Ross 308 and Hybro broiler strains.

MATERIALS AND METHODS

In the experiment, a total of 500 eggs, 250 fertile eggs from each of Hybro and Ross 308 broiler strains were used. The eggs were purchased from a commercial hatchery with a maternal flock at 40 wk in lay. The eggs of each strain were weighed and then divided into 2 groups as control and high incubation temperature exposed (heat-stress) groups. The control eggs of both strains were maintained under optimal conditions (incubation temperature: 37.8ºC) during the whole incubation period, whereas heat stress imposed eggs were maintained under 37.8ºC until the 10th day of incubation and then continuously exposed to high temperature (38.8ºC) in the incubator (VGS 108)[1]. Other environmental conditions were standardized. The 18th d of incubation eggs were transferred to hatchery baskets in the same machine.

At the 11, 13, 15, 18, 20 and 21st days of incubation, randomly sampled eggs from each group were opened until 10 living embryos were obtained from each group. The developmental stage of each embryo was determined according to the Hamburger-Hamilton scale [8]. The embryos and their yolk sacs were weighted with a digital balance[2] (sensitivity g ± 0.01) at the 11, 13, 15, 18 and 20th of incubation and chick weight with yolk sac were determined on hatching day (d 21 of incubation) of the groups. Mean relative embryo weights [(embryo weight/egg weight at setting) x 100] and relative yolk sac weights [(yolk sac weight/egg weight at setting) x 100] of each groups were calculated.

The parameters were analyzed by one way analysis of variance (ANOVA) and followed by post hoc Duncan multiple comparisons tests using the Statistical Package for Social Sciences (SPSS version 10.0).

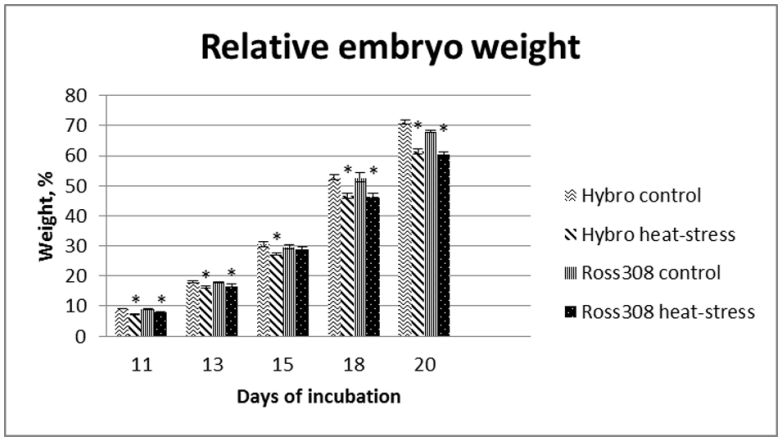

Figure 1. Relative embryo weight without yolk sac (%) at different incubation period of groups. Results are presented as means, and bars are SE. * Significantly different from control group at $P < 0.05$.

RESULTS

In both strain, the heat stress group had a significantly lower ($P < 0.05$) yolk-free embryo weight than the control group (Figure 1). However relative yolk weights in heat-stress groups were found to be significantly higher ($P < 0.05$) when compared to those in the control groups (Figure 2). There was no significant difference between mean embryo and yolk weights of the control groups both strains, except for embryo weight at 20th d of incubation. We also observed that the chicks were heavier at the day of hatch in heat-stress groups than the control groups (Figure 3). However the differences in chick weight at hatch between control and heat stress groups were statistically significantly only in Ross308 strain.

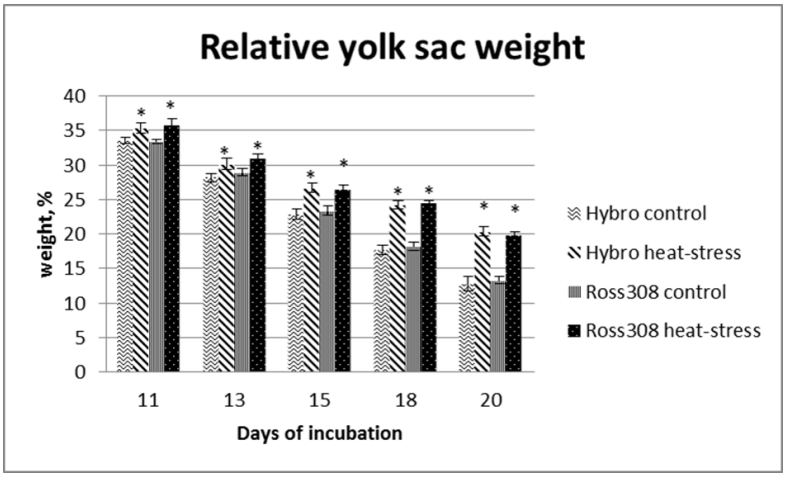

Figure 2. Relative yolk sac weight (%) at different incubation period of the groups. Results are presented as means, and bars are SE. * Significantly different from control group at $P < 0.05$.

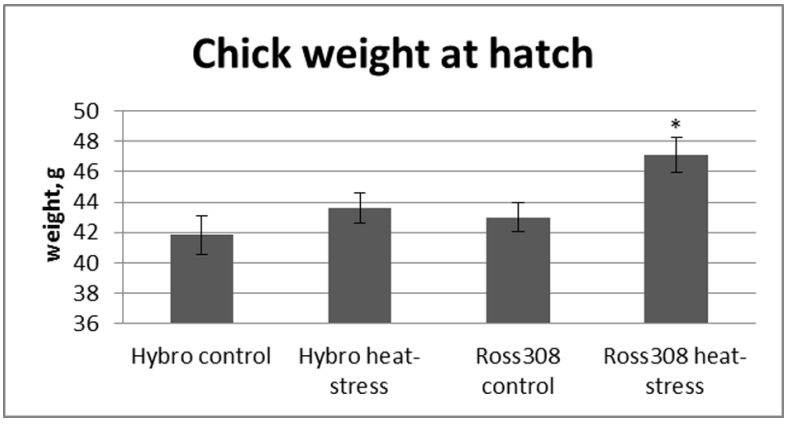

Figure 3. The chick weight with yolk sac (g) on hatching day (d 21 of incubation) of the groups. Results are presented as means, and bars are SE. * Significantly different from control group at $P < 0.05$.

DISCUSSION

Today's broiler chicken spend up to 30-40% of its total life inside the egg and anything affecting positively or negatively the growth and development during embryonic period can have a marked impact on posthatch performance of the chicken [2,9]. Chicken embryo is poikilothermic and relies on an external heat source for maintenance of its body temperature, since thermoregulatory system is established only a few days after hatching [17]. Therefore the incubation temperature is the most important environmental factor that affects embryonic development [5].

The geometry of incubator and settlement of heat sensors have vital importance in the incubator design [15]. Eggs absorb the heat from the surrounding air during the early incubation due to embryo temperature is slightly lower than incubator temperature. However, from mid-incubation onwards, embryo temperature

increases because of the higher heat production of the embryos [6] and problems with cooling capacity and air velocity in incubator [9,14].

It has been suggested that embryos are more sensitive to temperatures above 37.8ºC and some periods were found to be more and others less sensitive. Additionally the tolerance to deviations in temperature from the optimum depends on the duration of exposure to these deviations [5]. In a study of embryos exposed to thermal manipulation (39.5°C) from embryonic day 7 to 16 have been reported that continuous thermal manipulation negatively affected hatchability and performance parameters, whereas intermittent (12 h) thermal manipulation had no significant effect on these parameters [16]. However Barri *et al*. [2] suggested that no significant differences were observed in any performance characteristics and yolk weights of chicks from altering the incubation temperature.

In the present study, the effects of long-term high temperature (38.8ºC) from the 10th day to the end of incubation on the body weight and yolk consumption of embryos were evaluated in two broiler strain. In both strain, relative yolk free embryo weight of significantly declined in the heat-stress groups than those of the controls. Lekrisompong *et al*. [12] suggested that the elevated temperature generally accelerated hatching time but this was not in concert with the development of the organs. The differences in hatchability and chick quality in high temperature may be related to differences in nutrient use or the efficiency of nutrients absorbed from the egg [14]. The yolk and its fatty acid content are necessary for meeting the nutritional requirements of developing embryos [22]. We found that the yolk sac was significantly heavier in heat-stress groups. This finding suggests that embryos subjected to the high temperature consumed less yolk. Similarly Willemsen *et al*. [19] found exposing embryos to 40.6ºC from embryonic day 16 until embryonic day 18.5 reduced embryo growth and yolk consumption, resulting in a significantly lower yolk-free chick weight at hatch. It was observed that chicks incubated at elevated temperatures after embryonic day 14 present white down feathers instead of the normal yellow, probably due to poor absorption of yolk contents [12].

Since the immune system of the newly hatched chicks is not fully developed, maternal antibodies have important role in protecting them against specific or non-specific diseases [1]. Maternal antibodies are passively transferred from the hen to the offspring through the yolk and albumin [7]. Therefore decreased consumption of the yolk due to high incubation temperature will not only affect the hatchability and chick quality, but may also negatively affect the immune status of the newly hatched chick. Therefore further studies may be conducted to elucidate whether insufficiencies of the immune system occur because of the high incubation temperature.

The unexpected result obtained from the present study that body weight of the chicks at the hatch day was higher in the heat-stress groups of both strains in comparison to their controls. Greater amounts of remaining of unused yolk in the heat-stress groups may be responsible for this difference. This finding was in agreement with Wineland *et al*. [21] who reported that high temperature exposed chicks were heavier at hatch and they claimed that more residual yolk mass were responsible for the difference rather than tissue mass. Hulet *et al*. [9] also found that eggs incubated at high temperature resulted in heavier chick weights at hatch when compared with chicks from the middle or low temperature treatment. In a another study have been reported that different durations (3, 6, 12 or 24 h per day) of thermal manipulations (39.5°C) during embryonic day 16 to 18 did not the affect the body weight of the hatched chicks, but significantly affected hatchability [3].

CONCLUSION

In conclusion long-term high incubation temperature (38.8ºC) from the 10th day to the end of incubation resulted in reduced body weight and decreased yolk consumption of embryos. High incubation temperature affected two strains in a quite similar manner except for minor differences. Results of the present study have revealed that the efforts to increase the body weight of broilers should not be limited to management and care at post hatch period, incubation factors affecting the performance should be determined and taken the necessary precautions.

MANUFACTURERS

[1]Kap. Istanbul, Turkey.

[2]Sartorius. Goettingen, Germany.

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***Ethical approval*.** All experimental procedures were approved (number 2006/070) by the Ethical Committee of S.U. Veterinary Faculty, Konya, Turkey.

***Declaration of interest*.** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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