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The effects of non-ventilation environments in setters on hatching characteristics of broiler breeder eggs and progeny performance[1]

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Abstract

This study was designed to investigate the effects of non-ventilated incubator conditions during the first 10 and 14 days of incubation on fertile hatchability and 6 wk live performance of broiler chickens progenied from those treatments. Hatching eggs were obtained from broiler breeders (Ross 308) at 35 weeks of age. A total of 1152 eggs were used in the present study. All eggs were equally and randomly distributed into 3 incubators. The eggs of 3 groups were incubated under identical conditions at a set point 37.6 ^{0}C and a RH of 58% in setters for first 18 d of incubation. However, the ventilations procedures of the 3 groups were not identical. The first group were not ventilated from 0 to 10 d of incubation (NoV-10 d), whereas second group were not ventilated from 0 to 14 d of incubation (NoV-14 d). Thereafter, the NoV-10 d and NoV-14 d groups were incubated under standard conditions. The third group was designed as control and incubated under standard hatchery conditions during the whole incubation period. Newly hatched chicks were placed in floor pens and reared on common fed on commercial feeds and reared under standard management conditions from 1 to 6 wk of age. There were found that hatchability was improved in eggs incubated under the non ventilated incubator conditions until day 10 and 14 compared to control eggs. The time of hatch in chicks incubated under NoV-14 d conditions delayed.

Throughout rearing, live body weights and FCR values were better in NoV-10 d than that of Nov-14 d and control groups. Data in the current study suggest that exposure of the embryos to the NoV environment during the first 10 d or 14 d of incubation resulted in positive effects on fertile hatchability and some live performance parameters of progeny birds.

Keywords: *Broiler breeder, non-ventilation program, incubation, progeny performance*

Broyler Damızlık Yumurtalarında, Çıkış Makinelerine Uygulanan Havalandırmasız Kuluçka Şartlarının Kuluçka Sonuçları ve Broyler Performansına Etkileri

Özet

Bu çalışmada, broylerlerde kuluçkanın ilk 10 ve 14 günlük döneminde havalandırmasız kuluçka makine şartlarının kuluçka sonuçları ile aynı yumurtalardan çıkan civcivlerde çıkış sonrası 6 haftalık periyottaki performansa etkileri araştırılmıştır. Araştırma materyali olan 1152 adet kuluçkalık yumurtalar 35 haftalık yaştaki Ross 308 genotiplerden elde edilmiştir. Yumurtalar 3 adet gelişme kabinine eşit sayıda ve rasgele olarak dağıtılmışlardır. Makinelerde ilk 18 günlük kuluçka periyodu için sıcaklık 37,6 ^{0}C ve nem % 58 olarak ayarlanmıştır. 1. makinedeki yumurtalar ilk 10 gün havalandırmasız (NoV–10 d), 2. makinedekiler ise ilk 14 gün havalandırmasız ortamda (NoV–14 d) bırakılarak, tamamen kapatılmıştır. 3. makine ise kontrol grubu olarak planlanmış ve tüm kuluçka süresince standart kuluçka şartları uygulanmıştır. Çıkan civcivler kuluçkadaki orijinlerine göre planya talaşı serilen altlıklar üzerinde 6 haftalık yaşa kadar standart yetiştirme şartlarında büyütülmüşlerdir.

Çıkış gücü (ÇG) bakımından 10 ve 14 günlük deneme gruplarında ortalamalar kontrol grub ortalamasına göre daha yüksek bulunmuştur. Çıkış zamanı bakımından 14 günlük grup, 10 günlük ve kontrol grup ortalamalarına göre daha geciken bir çıkış eğilimi izlemiştir. Büyütme döneminde, canlı ağırlık ve FCR değerleri bakımından NoV–10 d grup ortalaması NoV–14 d ve kontrol grup ortalamalarına göre daha yüksek bulunmuştur. Çalışma sonuçlarına göre kuluçkanın ilk 10 ve 14 günlük periyodu boyunca havalandırmaların kapatılması gerek kuluçka gerekse çıkış sonrası performans değerleri bakımından faydalı olacağı kanaatine varılmıştır.

Anahtar Kelimeler*: Broyler damızlık, havalandırmasız program, kuluçka, çıkış sonrası performans*

Introduction

Oxygen dependency for embryonic growth and development has been probed for decades but there remains some disagreement as to when embryos were sensitive to hypoxia and whether the effects were reversible by return to normoxia (Chan & Burggren, 2005). It has previously been demonstrated that reduced oxygen concentration between 7 and 14 d of incubation induced an increased chorioallantoic membrane capillary density and elevated hematocrit. Interestingly,

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embryos that had been incubated in low oxygen from 0-10 d had body weight and liver:brain ratios similar to control chicks at hatching despite differences being observed at 15 d of incubation (Miller *et al*., 2002). Studies have shown that incubator CO_2 concentrations of more than 1% during the first 4 d or 3% from 5 to 8 d of incubation adversely affect hatchability (Taylor & Kreutziger, 1965). However, it has been more recently reported that non-ventilation (NoV) of the incubator during the first 10 d of incubation, which caused a gradual increase in CO_2, improved hatchability (De Smit *et al*., 2006). Further, Tona *et al.* (2006) concluded that NoV during the first 10 d shortened incubation period, but had no effect on fertile hatchability. Bruggeman *et al.* (2006) indicated that gradually increasing CO_2 to 1.5% during the first 10 d of incubation produced a dramatic decrease in albumen pH. There are a few study which combines non ventilated environment and 6 wk live performance of broiler chickens progenied from those eggs.

The objective of the present study was to assess the effects of NoV conditions during the first 10 and 14 d of incubation on hatching characteristics and subsequent broiler performance.

Materials and Methods

A total of 1152 Ross x Ross 308 eggs obtained from a breeder flock at 35 wk were allocated randomly into three identical laboratory setters. The eggs were incubated at a set point 37.6°C and a relative humidity (RH) of 58%.

The only difference among the setters was the ventilation procedures of each machine. The first group were incubated at conventional conditions (Control) and normally ventilated during the whole incubation period. The second group were not ventilated from 0 to 10 d of incubation (NoV-10 d) and ventilated from d 11 of incubation till hatch. The third group were not ventilated from 0 to 14 d of incubation (NoV-14 d) and ventilated from d 15 of incubation till hatch. The eggs remained in the setters until at the completion of 17 d of incubation. At day 18 of incubation, the eggs from all groups were transferred to two identical hatchers. The temperature and RH was 37.1C and 75 %, respectively from transfer to hatch in both hatchers. Hatching time was monitored at 486 h, between 487 and 510 h and 511-516 h of incubation. The operation of the two hatchers was monitored closely to ensure that the operation of the incubators was as precise and accurate as possible in order to minimize machine effects. At hatch, saleable chicks were weighed and feather sexed.

All eggs that did not hatch at the end of the incubation period were broken out and examined macroscopically to determine fertility and embryonic death stages (early/ mid term and late) for each groups. The eggs were assigned to one of the following categories: Infertile, early/mid term deaths (E-MD) (from 0 to 14 d) and late term deaths (LD) (15 to 21 d). Total incubation time was calculated as the time between setting and emergence. Hatchability and percentage of embryonic mortality were computed as the percentage of fertile eggs for each tray. There were 8 trays of 48 eggs each treatment subclass, for a total of 24 trays for the entire experiment.

240 Male chicks were placed in 12 floor pens (0.03 m^2/ chick), providing 4 replicates pens for each treatment group to determinate of live performance of birds. Bird weights and food intakes were recorded on group basis. Birds were reared under continuous lighting with feed and water supplied *ad libitum*. Chicks were fed common corn-soybean meal rations throughout rearing. The starter ration (3,175 kcal of ME/kg, 22 % CP) was fed from 0 to 21 d of age and the grower ration (3,200 kcal of ME/kg, 20 % CP) from 22 to 42 d of age. The live weight gain (LWG), Feed Consumption (FC) and Feed Conversion Rate (FCR) were determined at 42 d of age.

A completely randomized design was used at this trial. The data were analyzed using General Linear Model's procedure for analysis of variance (Minitab, 1998). The differentiations among the group means were detected by using Duncan's Multiple Comparisons Range Test (Mstat-C, 1989).

Results and Discussion

Incubation results

The effects of incubator ventilation treatments on embryonic mortality stages and fertile hatchability (FH) were presented in Table 1. The E-MD were reduced when eggs were exposed to *non* ventilated incubation conditions for first 10 d of incubation ($P<0.05$). The highest late term mortality observed in the CON group ($P<0.05$). The FH was significantly higher in the NoV-10 d and NoV-14 d groups than that of CON group ($P<0.05$).

Table 1. Effects of ventilation treatment on fertile hatchability and embryo mortality (Means± SE)

Variables	Groups		
	Control	NoV-10 d	NoV-14 d
	(% of fertile eggs)		
E-MD	6.8 ^{a} ±1.16	2.9 ^{b} ± 0.57	**5.2^{ab} ± 0.76**
LD	9.7 ^{a}±0.62	3.4 ^{b} ± 0.95	**3.1^{b} ± 0.94**
FH	**83.5^{b} ±1.60**	**93.8 ^{a} ± 0.89**	**91.8 ^{a} ± 1.35**

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

These findings agree with that of De Smit *et al.* (2005), who stated that a gradual increase of CO_2 in the incubator during the first 10 d of incubation changed the embryonic curve, shifted the hatching

curve. Yildirim *et al.* (2007), who stated that exposure of the embryos to the NoV environment during the first 10 d of incubation, resulted in positive impacts on embryo survival and hatchability. The effects of *non*-ventilation conditions for first 14 d of incubation for FH seemed to be similar to NoV-10 d. The beneficial impacts of non-ventilated environment in current study on hatchery results might be a result of high CO_2 concentration in the setters. Chan & Burggren (2005) stated that from the first hours to few days of development, vertebrate embryos exhibit relatively high rates of anaerobic metabolism. Interestingly, yolk mass were consumed at a significantly greater rate in hypoxic embryos. Latter&Baggott (2002) stated that during early incubation the concentration of CO_2 at the endodermal cells is important for the normal production of sub-embryonic fluid (SEF). Deeming (1989) stated that CO_2 is essential for SEF production. Further the production of this fluid is a pivotal event of early development. Chan & Burggren (2005) stated that irrespective of whether chicken embryos were experiencing hypoxia for the first time in late development or had been incubated constantly under hypoxic conditions Corioallantoic membrane masses were significantly higher in chicken embryos exposed to hypoxia. Additionally, yolk consumption of the embryos was stimulated by hypoxic exposure. Noble & Cocci (1990) stated that the development of the avian embryo is dependent on aerobic metabolism and features the β-antioxidant of fatty acids derived from yolk lipids. The rate of oxygen consumption increases dramatically from about the mid-period of the 21 d development partly because of the growth of the embryo. Such increases in mitochondrial respiration and oxygen uptake are obligatory aspects of embryonic development, providing the energy for tissue growth, transport of nutrients from the yolk, maintenance of the heartbeat and other essential functions. However, it is likely that these beneficial aspects may be accompanied by potentially harmful effects because high rates of energy metabolism can lead to the production of reactive oxygen species and other free radicals which can cause damage to cellular macromolecules. We have speculated that *non* ventilated environment probably have a beneficial contribution on albumen quality. Walsh *et al.,* (1995) investigated the effect of storage of chicken eggs while Yetisir *et al.,* (1997) have performed the similar study on turkey hatching eggs for 14 days before incubation confined in plastic bags on hatching results. Both study found that the eggs stored in high CO_2 environment has showed increased apparent hatchability, a decrease in the numbers of early dead embryos and a lower albumen pH (possibly through the slowing down of loss of CO_2 and a maintenance of pH). Rouwet *et al.,* (2002) demonstrated that chronic hypoxia during embryonic development in high altitudes induces structural and functional cardiovascular abnormalities in near term embryos chicken embryos. These abnormalities may be responsible for the increased mortality of embryos incubated under high altitude. However, the negative effects of high altitude on lower hatchability and higher embryonic mortalities may only not be attributable to only chronic hypoxia in high altitudes. Visschedijk (1991) stated that the impairment of FH is caused by the reduced barometric pressure at altitude which not decreases effective eggshell conductance. Therefore, the combined effects of altitude are a lack of oxygen, an excessive loss of CO_2 and an excessive water loss.

The effects of ventilation treatments on hatching time were presented in Table 2. The percentage of chicks hatched, expressed as the percentage of all chicks hatched, showed a delayed hatching in the NoV-14 d group at 486 h of incubation. Conversely, greater percentage of chicks completed hatching process between 499 and 510 h of incubation in NoV-14 d group.

Table 2. Effects of ventilation treatment on hatching time (Means± SE)

	Groups		
Chick Hatching Time	**Control**	**NoV-10 d**	**NoV-14 d**
	(% of total chicks that hatched)		
Early (before 486 h)	62.4 ^{a} ± 6.58	41.6 ^{a} ± 4.74	**1.2 ^{b} ± 0.92**
Middle (between 487 and 510 h)	37.6 ^{c} ± 1.60	58.4 ^{b} ± 4.73	**98.8 ^{a} ± 4.57**
Late (between 511-516 h)		**NC**	

$^{a,b,c;}$ *Means ± SE with different superscripts differ significantly (P ≤ 0.05).*
NC: No chicks hatched at this stage

These results differ from those of Tona *et al*. (2006) and of De Smit *et al.* (2006) who stated that *non*-ventilated incubator environment during the first 10 d of incubation decreased overall hatching time. De Smit *et al.* (2006) found that chicks incubated under NoV conditions hatched 10 h earlier and the total hatching time lasted less than that of CON. In the study, the spread of hatch in NoV-14 d group was narrower than that of the spread of the NoV-10 d and control chicks. This finding disagrees with that of Bruggeman *et al.* (2006) who found that the chicks hatched earlier incubated in high CO_2 concentration

environments than the chicks incubated under standard conditions during the fist 10 d of incubation. These conflicting results might be explained by the contribution of other environmental factors in incubators such as uniform temperature and RH levels as well as high CO_2 concentrations or their synergic effects in incubators rather than independent effect of CO_2 concentration. Furthermore, the breeder ages which were used in these studies might be responsible for the obtaining of different incubation results. Suarez *et al.,* (1997) found that hatching was significantly affected by hen age, with the middle-aged breeder showing a shorter incubation time in relation to that of younger flocks. Yildirim *et al.* (2007) stated that the beneficial contribution of *non* ventilated environment in incubators during the first 10 d of the incubation on FH may be a result of providing more uniform temperature or decreasing albumen pH more rapidly with higher RH and CO_2 concentrations in incubators.

Progeny Performance

The effects of *non*-ventilation treatments on chick weight at hatch (Cw_H), LWG, FC and FCR values at slaughter were shown in Table 3. Cw_H was heavier in NoV-14 d group compared to other treatment groups. LWG at slaughter of broilers was higher in NoV-10 d group than that of other treatment groups. Furthermore, the better FCR values were calculated in NoV-10 d group. No significant differences were found among groups for FC.

Table 3. Effects of ventilation treatment on broiler performance to 42 d of age (Means± SE)

Variables	Groups		
	Control	**NoV-10 d**	**NoV-14 d**
Cw_H* (g)	36.6[b]±0.22	37.5[b]±0.25	**38.6[a]±0.48**
LWG (g)	1763.4[b] ±25.7	1911.5[a] ±52.0	**1833.9[ab] ±30.0**
FC (g)	3561.4±67.15	3603.2±106.2	**3557.0±18.2**
FCR g:g	2.02[a] ±0.03	1.89[b] ±0.02	**1.94[ab] ±0.04**

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

The differences among groups for Cw_H might be a result of hatching time. Because the important portion of total chicks from both NoV-10 d and control group have completed their incubation period more earlier and stayed more longer in hatchers rather than that of chicks from NoV-14 d group. This finding agrees with Swann & Brake (1990) who stated that time of hatch is important because chicks held in incubator trays for 14 to 32 h post-hatch weighed 5 to 12 % less than chicks removed promptly.

In spite of lower chick weights at hatch, the better LWG and FCR were obtained in NoV-10 d group at 6 wk of age. These findings disagree with Swann & Brake (1990) who stated that the reduction in chick weights due to long holding time at hatching baskets at hatch persisted to 49 d of age. As a consequence, that weight may never be regained due to the age at which broilers marketed. In spite of lower chick weights at hatch, and long holding time of chicks in hatchers from NoV-10 d, the chicks recovered during rearing and exceeded the weights of other treatment groups. Results from present study showed that a probable compensatory growth in NoV- 10 d chicks occurred whereas no compensatory growth was detected in control group. Results are comparable to findings by Yildirim *et al.* (2007), who incubated eggs at different RH profiles with no ventilation for first 10 d of incubation and concluded that non ventilated eggs in incubators for first 10 d of incubation improved both hatchability and chick weight at pull time whereas body weight gain and feed conversion were not affected.

Conclusion

In conclusion, these results may show that exposure of embryos to proposed ventilation program in incubators improves hatchability, live weight gains and feed conversion ratios of broiler. The most favorable contribution of non-ventilated environment on fertile hatchability, FCR and live weight gains were found in NoV-10 d group.

We suggest that future experiments should be directed towards understanding the physiological underpinnings of the *non* ventilation programs for the first 10 d of incubation rather than 14 d.

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