10.22059/IJVM.2021.322869.1005170

Iranian Journal of Veterinary Medicine
Volume 15- Issue 03

Original Article

Online ISSN: 2252-0554

Effects of Hatching and Feeding Times and Hatchery Temperature on Body and Organs' Weight of Post-hatched Chicks

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Abstract

BACKGROUND: In commercial hatcheries, chicks are deprived of feed and water for up to 72 h, which is a detrimental effect on growth performance.

OBJECTIVES: Two experiments were designed to investigate the effect of hatching parameters and feeding time on the body and organ weights of chickens.

METHODS: In the first experiment, 300 of both early- and later-hatched broiler chicks received feed immediately after hatching or 48 h later and were divided into four experimental groups. The body and internal organ weights of chicks were determined for up to seven days. In the second study, 370 embryos, which were incubated in a setter until the 18th day, were transferred to two hatchers, which differed their air and eggshell temperatures. Then, hatching and post-hatched parameters were followed.

RESULTS: Comparing early-hatched chicks, later-hatched chicks had significantly greater weight ($P<0.05$) on day 3 and better yolk utilization and higher relative liver and intestine ($P<0.01$) weights on day 2. However, early-fed chicks indicated significantly higher body weight ($P<0.0001$) until day 7 and early yolk utilization and higher internal organ weights than later-fed chicks. In the second experiment, when the air temperature of hatcher A (control) was kept at 37.5ºC, its eggshell temperature was determined at 38.5ºC, while the eggshell temperature of hatcher B was optimized at 37.5ºC, and its air temperature showed 36.5ºC. Earlier hatchability was higher in the control hatcher (46.8%) than hatcher B (27.1%), but later hatchability was reversed. However, final hatchability was lower in hatcher B (96.6%) than the control hatcher (98.3%).

CONCLUSIONS: Later-hatched and early-fed chicks showed greater body and internal organ weights, indicating better maturation of these chicks. The results of the second study indicated that the hatching window could be shorter and also shifted to the end of the incubation time by reducing the egg temperature.

KEYWORDS: Chicks, Eggshell, Feed, Hatch, Temperature

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Received: 2021-04-04

Accepted: 2021-06-01

How to Cite This Article
Hassanzadeh, M ., Decuypere, E. (2021). Effects of Hatching and Feeding Times and Hatchery Temperature on Body and Organs' Weight of Post-hatched Chicks. *Iranian Journal of Veterinary Medicine, 15*(3), 275-285.

Introduction

In commercial hatcheries, chicks do not hatch out all at the same time, and there is a hatching window ranging from 24 h to 48 h. In practice, all chicks stay in the incubator until almost all have hatched. Normally, they receive neither feed nor water before transferring to the broiler house. For early-hatched chicks, this dietary- and water-deprived period can take up to 72 h. However, in many countries, there is a long distance between the hatchery and the broiler farm; therefore, the producer often has no options during shipment of birds over long distances (Willemsen *et al.*, 2010). When after hatching, feed and water deprivation exceeds 24 h, which is common in commercial practice, it results in stress and can have long-lasting effects on growth performance, yolk utilization, intestinal developments, immune system activities, and increased early mortality (Van Roovert, 2016; Willemsen *et al.*, 2010). Juul-Madsen *et al.* (2004) reported that chicks deprived of food for 48 h after hatching indicated poor viability and immune performance, as they showed poor growth and delayed developmental changes in circulating immune cells.

Eggshell temperature is influenced by embryonic heat production and heat transfer capacity of the air that depends on air temperature, relative humidity, and also airspeed or ventilation over the eggs; all of these are greatly dependent on incubator design. Temperature is one of the most important drivers of embryo development and, therefore, chick quality and their subsequent performances. Lourens *et al.* (2005) showed that eggshell temperature lower than 37.8°C during the first week of incubation resulted in a higher percentage of second-grade chickens up to 5% and shorter chick length. The high eggshell temperature during the hatching phase decreased chick development (Maatjens *et al.*, 2016a, 2016b).

The OvoScan system is a method that can read eggshell temperatures and, accordingly, adjust the air temperature of the incubator. Therefore, the embryonic environment temperature is continuously adjusted in response to the actual eggshell temperature. This enables the constant creation of the optimum embryonic temperature. It is led to control the rate of metabolic development and heat production of the embryo, influencing hatching parameters and hatching window (Decuypere & Mitchels, 1992; Ipek *et al.*, 2014; Nangsuay *et al.*, 2016), as it was also affected by environmental hypoxia (Hassanzadeh *et al.*, 2004, 2019).

In the present work, two independent experiments were designed. In the first experiment, chicks from different periods of the hatching window were given immediate or 48-h delayed feed. The purpose was to investigate the effect of hatching time with early- or later-feed access on the absolute body weight, relative yolk sac and internal organ weights, and heterophil/lymphocyte in post-hatch broiler chicks.

Regarding the results of the first experiment, the second experiment was designed as a pilot study. The main aim was to answer the question of whether the period of the hatching window could be reduced. Thus, the OvoScan system, a method for measuring eggshell temperature, was used to determine the air temperature of the incubator, consequently hatching parameters, and finally post-hatch performance of chicks followed, as has been done in the first experiment.

Materials and Methods

Experiment 1

A total of 500 Ross 308 eggs with almost equal weight from a commercial broiler breeder flock around 48 weeks of age were placed in an incubator (Pas Reform BV, Zeddam, The Netherlands) under standard conditions for hatching. Hatched-chicks were divided into three categories regarding their hatching time process: Chicks hatched before 480 h of incubation were considered as early-hatched, between 490 h and 504 h as later-hatched, and between 480 h and 490 h as middle-hatched chicks, which the latter group was omitted and not used in this study.

Therefore, 300 chicks from both early- and later-hatched (150 chicks/hatched) were individually weighed and subjected to 12 pens in the same room. Each group, regarding their feeding process (i.e., early feed, immediately after hatching, and later feed 48 h after hatching), was again randomly divided into two subgroups, in total four groups (three pens/25 chicks/group). All birds were reared under a nearly continuous lighting program (23 h L: 1D) and had *ad libitum* access to water and commercial broiler food until 7 days of age. On days 0, 1, 2, 3, and 7 of age, seven chicks from each experimental group were randomly selected. First, chicks were weighed individually, and blood samples were taken for determination of the H/L ratio (Weimer, 2018). Then, they were slaughtered to measure the internal organs, yolk sac, liver, and total small intestines (empty). The weight of the internal organs was calculated as the percentage of chick body weight (Raji *et al.*, 2017).

Experiment 2

Four hundred eggs with almost equal weight from a breeder broiler farm were obtained and incubated in one setter (Pas Reform BV, Zeddam, The Netherlands) under standard conditions at 37.8°C with a relative humidity of 56%. On the 18th day of incubation, 370 survived embryos were transferred and divided into two different hatchers, carefully controlled by the OvoScan system (Figure 1). Hatcher A (control)**:** its air temperature was constant at 37.5ºC with 66% relative humidity, and the eggshell temperature was automatically measured using the OvoScan system, which was fixed to eggshells until chicks hatched. Hatcher B: the eggshell temperature was constant at 37.5°C, but its air temperature was measured until chicks hatched.

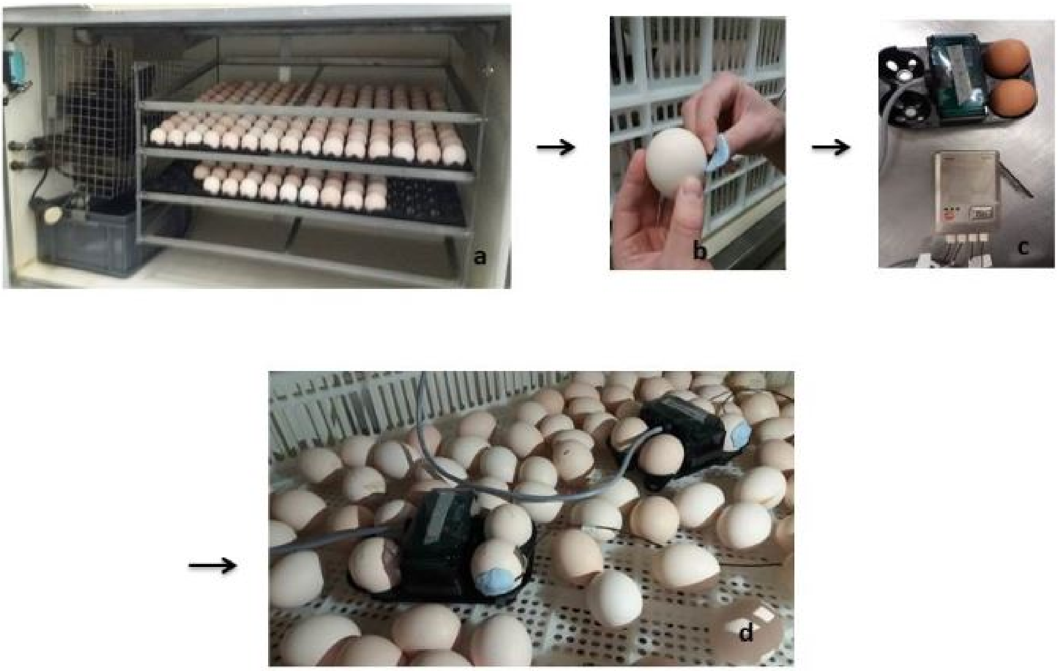

Figure 1. The procedure of OvoScan; a; Eggs in setter; b: Censor fixating to egg shells; c: Electronic tools of Ovoscan; d: Hatcher is determining the egg shell temperature.

During the hatching period, related hatching parameters e.g. percentages of hatchability at different periods and not hatched embryos were recorded. At the end of the hatching, 40 pulled chicks from each hatcher were randomly selected to determine chick quality by Tona score measurement (Tona *et al.*, 2003). Then, a total of 150-day-old chicks from each hatchery were randomly selected (75 chicks-/hatcher), weighed, and divided into six pens (three replicates/ 25 chicks each). They were reared under a nearly continuous lighting program (23 h L: 1D) and had *ad libitum* access to water and commercial broiler food until 5 days of age. On days 1 and 5 of age, eight chicks from each hatchery group were randomly selected, weighed, and slaughtered to determine relative internal organs of the yolk sac, liver, heart, and total small intestine weights. Such measurements were also performed by sampling the external piping embryos on the 19th day of incubation.

Statistical Analyses

Statistical analyses were performed using the general linear model procedure (SAS Institute Inc., 2010). If a significant overall effect ($P \leq 0.05$) was found, treatment means were again compared using the LSMEANS procedure.

Results

Experiment 1

The results of the absolute body weights of new-hatched chicks are presented in Table 1. Later-hatched chicks showed significantly greater weights compared to early-hatched chicks from day 2 onward, but the difference was only significant ($P<0.05$) at 3 days old. From day 2 onward, chicks that received early feed indicated significantly higher absolute body weight when compared to birds deprived of feed. Additionally, significant hatching and feeding interactions were present on absolute body weight at 2 ($P<0.05$) and 7 ($P<0.01$) days old. Later-hatch and early-feed chicks showed significantly higher body weight compared to early-hatch and early-feed chicks on the mentioned days (Tables 1 and 2), indicating that in the same feeding birds, those chicks that hatched later had faster growth compared to early-hatched chicks.

Table 1. Absolute body weights (g) and the yolk sac weights as percentage of body weight at the different days in post hatched-chicks.

Parameters		Groups	Days 0	1	2	3	7
Body weight	Hatch	Eh	46.8 ± 0.82	45.8± 0.96	45.9 ± 1.35	51.9 ± 1.38b	110.2 ± 4.1
		Lh	46.4 ± 0.78	44.6± 1.04	47.9 ± 1.91	57.1 ± 2.22a	116.6 ± 3.4
	Feed	Ef	46.2 ± 0.87	45.7 ± 1.03	51.6 ± 1.63a	57.4 ± 1.34a	123.2 ± 4.24a
		Lf	46.9 ±0.71	44.7 ± 1.14	41.7 ± 1.05b	51.6 ± 1.04b	103.6 ± 2.55b
	P-values	Hatch	NS	NS	NS	0.05	NS
		Feed	NS	NS	0.0001	0.05	0.0001
		Hatch × feed	NS	NS	0.05	NS	0.01
Yolk sac	Hatch	Eh	17.04 ± 0.82a	12.80 ± 0.50a	7.15 ± 0.36a	3.08 ± 0.29	0.19 ± 0.05
		Lh	12.97 ± 1.13b	9.52 ± 0.59b	4.59 ± 0.54b	2.34 ± 0.28	0.11 ± 0.03
	Feed	Ef	15.16 ± 0.84	10.88 ± 0.68	4.60 ± 0.41b	2.06 ± 0.27b	0.14 ± 0.05
		Lf	15.01 ± 1.39	11.49 ± 0.76	6.14 ± 0.58a	4.26 ± 0.29a	0.15 ±0.02
	P-values	Hatch	0.01	0.001	0.001	NS	NS
		Feed	NS	NS	0.005	0.05	NS
		Hatch × feed	NS	NS	0.005	NS	NS

Within columns in each age and parameter, means with no common superscripts are significantly different ($P<0.05$).
Eh= Early hatch; Lh= Later hatch; Ef= Early feed; Lf= Later feed;

Early-hatched chicks showed higher yolk sac weights as the percentage of body weight at all ages––but they were significant at 0 ($P<0.01$), 1 ($P<0.001$), and 2 ($P<0.001$) days old. There was a significant influence of feeding time on yolk sac weight, as those chicks fed immediately after hatching showed significantly lower relative yolk sac weights (faster yolk utilization) compared to later-fed chicks at 2 ($P<0.005$) and 3 ($P<0.05$) days old (Table 1). At 2 days old, there was a significant ($P<0.005$) interaction between hatching and feeding time on relative yolk sac weight (Table 2). At this age, later-hatch and early-feed chicks showed significantly lower relative yolk sac weight compared to early-hatch and early-feed chicks, indicating the permanent of later hatch on yolk uptake in same feeding chicks.

Table 2. Means for the effect of hatching and feeding time interaction on absolute body weight, relatives yolk and intestinal weights of new hatched chicks

	Body weight		Relative yolk	Relative intestine
Groups/age	Day 2	Day 7	Day 2	Day 2
EhEf	49.59 ± 0.71b	118.5 ± 2.35b	7.19 ± 0.64	4.01 ± 0.17b
LhEf	53.79 ± 0.65 a	126.8 ± 3.02a	4.04 ± 0.58	5.23 ± 0.28 a
EhLf	42.39 ± 0.36c	104.1 ± 3.85c	7.14 ± 0.49	3.07 ± 0.32b
LhLf	41.19 ± 0.47c	103.2 ± 2.75c	5.25± 0.63	3.53 ± 0.49b
P-values for Hatch × feed	0.05	0.01	0.005	0.05

Within columns in each age and parameter, means with no common superscripts are significantly different (*P*<0.05). EhEf= Early hatch and early feed; LhEf= Later hatch and early feed; EhLf = Early hatch and later feed; LhLf= Later hatch and later feed;

Table 3. Liver and small intestines weights as percentage of body weight at the different days in post hatched-chicks

			Days				
	Parameters	**Groups**	**0**	**1**	**2**	**3**	**7**
Liver	Hatch	Eh	1.79 ± 0.04b	2.29 ± 0.05b	3.07 ± 0.13b	4.67 ± 0.19	4.23 ± 0.14
		Lh	2.06 ± 0.06a	3.12 ± 0.04a	3.93 ± 0.11a	4.71 ± 0.19	3.94 ± 0.17
	Feed	Ef	1.98 ± 0.05	2.94 ± 0.02a	3.98 ± 0.15a	4.64 ± 0.14	4.86 ± 0.17b
		Lf	1.85 ± 0.06	2.16 ± 0.04b	2.02 ± 0.10b	4.74 ±0.22	3.11 ± 0.14a
	P-values	Hatch	0.001	0.0001	0.01	NS	NS
		Feed	NS	0.05	0.0001	NS	0.05
		Hatch × feed	NS	NS	NS	NS	NS
Small intes-tines	Hatch	Eh	1.73 ± 0.05b	2.72 ± 0.24b	3.15 ± 0.19b	4.87 ± 0.24	5.43 ± 0.17
		Lh	2.09 ± 0.08a	3.73 ± 0.15a	4.64 ± 0.25a	5.01 ± 0.37	5.68 ± 0.34
	Feed	Ef	1.97 ± 0.05	3.76 ± 0.13a	4.83 ± 0.22a	5.57 ± 0.19a	5.27 ± 0.22
		Lf	1.83 ± 0.08	2.49 ± 0.21b	3.30 ± 0.08b	4.11 ± 0.28b	5.34 ± 0.32
	P-values	Hatch	0.001	0.05	0.01	NS	NS
		Feed	NS	0.01	0.0001	0.001	NS
		Hatch × feed	NS	NS	0.05	NS	NS

Within columns in each age and parameter, means with no common superscripts are significantly different (*P*<0.05). Eh= Early hatch; Lh= Later hatch; Ef= Early feed; Lf= Later feed;

The liver weights as the percentage of body weight were significantly lowered in early-hatched chicks when compared to later-hatched chicks until day 2. However, early-fed chicks showed significantly higher relative liver weights at 1 (*P*<0.05), 2 (*P*<0.0001), and 7 (*P*<0.05) days old (Table 3). The phenomenon of the small intestinal weights was almost the same as the body and liver weights, as it was significantly lower in early-hatched chicks at 0 (*P*<0.001), 1 (*P*<0.05), and 2 (*P*<0.01) days old (Table 3). There was a significant influence of feeding time on relative intestinal weights at 1 (*P*<0.001), 2

(*P*<0.0001), and 3 (*P*<0.001) days old. Early-fed chicks showed significantly heavier small intestinal weights as the percentage of body weights than later-fed birds at those ages. Again, a significant (*P*<0.05) interaction between feeding and hatching time was found on the small intestinal weight at 2 days old (Table 2). Later-hatch and early-feed chicks showed heavier relative intestinal weight when compared to early-hatch and early-feed chicks, proving again the importance of later hatching within the same feeding birds.

There was no hatching influence on the H/L ratio, but the H/L ratio was significantly (*P*<0.0001) higher in later-fed chicks compared to early-fed chicks at 3 days old, causing stress in chicks deprived of feed (Table 4).

Table 4. The H/L (heterophil/ lymphocyte) ratio at the different days in post hatched-chicks

		Days		
Parameters	**Groups**	**1**	**3**	**7**
Hatch	Eh	0.425 ± 0.03	0.553 ± 0.11	0.546 ± 0.12
	Lh	0.416 ± 0.05	0.530 ± 0.06	0.542± 0.08
Feed	Ef	0.420 ± 0.05	0.417 ± 0.08b	0.547 ± 0.11
	Lf	0.427 ± 0.07	0.656 ± 0.17a	0.542 ±0.08
P values	Hatch	NS	NS	NS
	Feed	NS	0.0001	NS
	Hatch × feed	NS	NS	NS

Within columns in each age and parameter, means with no common superscripts are significantly different (*P*<0.05).
Eh= Early hatch; Lh= Later hatch; Ef= Early feed; Lf= Later feed;

Experiment 2

When eggs were incubated in hatcher A with the constant air temperature of 37.5ºC, the eggshell temperature of the control hatcher was determined with an average of 38.5ºC. However, in hatcher B, when the eggshell temperature was kept at 37.5ºC, its air temperature was determined 36.5ºC (average), which was 1ºC lower than in hatcher A (Table 5). Regarding two hatchers, the first hatch was observed in hatcher A (two chicks), while no eggs hatched in hatcher B up to 475 h of incubation. The percentage of earlier hatchability up to 490 h of incubation was markedly higher (46.8%) in hatcher A compared to hatcher B (27.1%).

However, at the last stage, between 490 h and 504 h of incubation, the percentage of later hatchability was clearly higher (69.5%) in hatcher B than in hatcher A (49.7%). At the end of the hatching process, the percentage of total hatchability was numerically lower in hatcher B (96.6%) compared to hatcher A (98.3%). When 40 newly pulled-hatched chicks from each hatcher were evaluated for chick quality (Tona score), the average chick quality score of two hatchers was almost the same, but it was better in hatcher A (99.4%) than in hatcher B (98.8%). In contrast, non-hatched eggs or embryonic mortality was numerically higher in hatcher B (6/177 embryos) than in hatcher A (3/177 embryos).

No hatchery effect was observed neither on the absolute body weight of external piping embryos on the 19th day of incubation nor on the body weights of post-hatch chicks at 1 and 5 days old. Regarding internal organ weights in the second study, as presented in Table 6, a significant (*P*<0.05) higher relative heart weight to body weight was only seen in the external piping embryo of hatcher B compared to hatcher A.

Table 5. The results of optimized air and egg shell temperatures, different times of the hatchability and quality score in 40 new hatched-chicks.

Groups/ Parameters that were followed	Hatcher A		Hatcher B	
Air temperature during hatching time	37.5 ºC		36.5 ºC	
Egg shell temperature during hatching time	38.5 ºC		37.5 ºC	
Number/percentage	Nr.	Percentage	Nr.	Percentage
First hatched up to 475 hours	2	1.1 %	Not hatched	-
Hatched at 480 hours	10	5.6 %	1	0.56 %
Earlier hatched up to 490 hours	83	46.8 %	48	27.1 %
Later hatched within 490-504 hours	88	49.7 %	123	69.5 %
Final hatched at the end of 504 hours	174	98.3 %	171	96.6 %
Not hatched embryos	3/177	1.7 %	6 /177	3.4 %
Average chick quality score (total 40 chicks/from 100 %)	-	99.4 %	-	98.8 %

Table 6. Absolute body weight, relative heart, yolk sac, liver and small intestinal weights as percentage of body weight, in external piping embryos and at days 1 and 5 of post hatched-chicks

Age	Hatchers	BW (g)	Heart % BW	Yolk % BW	Liver % BW	Small intestines % BW
***Ext. pip. Em.**	A	46.5 ± 1.01	0.372 ± 0.01b	19.11 ± 0.09	1.59 ± 0.06	1.34 ± 0.07
	B	47.2 ± 0.65	0.462 ± 0.02a	18.02 ± 0.57	1.62 ± 0.03	1.32 ± 0.08
Day 1 chicks	A	44.3 ± 0.92	0.588 ± 0.02	13.02 ± 0.64	2.06 ± 0.05	2.25 ± 0.07
	B	44.6 ± 1.83	0.622 ± 0.02	12.34 ± 0.62	2.24 ± 0.06	2.49 ± 0.12
Day 5 chicks	A	84.8 ± 2.79	0.684 ± 0.02	0.75 ± 0.11	4.42 ± 0.22	6.03 ± 0.27
	B	83.4 ± 1.64	0.687 ± 0.02	0.82 ± 0.20	4.23 ± 0.24	5.83 ± 0.24

*External piping embryo at 19^{th} day of incubation
Within columns in each age, means with no common superscripts are significantly different (P<0.05).

Discussion

Early access to feed and water after hatching has been shown to be an important factor for subsequent performance. In the present study, 48-h delayed feed for newly hatched chicks resulted in retarded growth at the first week of age, which is in agreement with previous reports (Wang, 2016). The later-hatched chicks indicated greater body weight compared to early-hatched chicks, confirmed by recent reports (Wang, 2016; Wang *et al.*, 2016).

Several researchers mentioned the involvement of AMP-activated protein kinase (AMPK) in different neonatal performances of chicks hatched at different times (Steinberg & Kemp, 2009; Wang, 2016; Wang *et al.*, 2016). The authors found a significantly higher level of hypothalamic AMPK in their later-hatched chicks than in early-hatched chicks and suggested that it could regulate energy metabolism in response to nutrient and hormonal signals at the cellular and whole-body level. However, AMPK was not measured in our study, but regarding our lab personal communications (KUL, Belgium), the higher activity of AMPK in later-hatched chicks might be responsible for more energy intake and lower energy expenditure, resulting in faster post-hatch growth. The relative yolk sac weights as the percentage to chick weights were significantly lower in later-hatched chicks, confirmed the earlier study of Wang (2016) that showed yolk utilization after hatching was faster for the later-hatched chicks. The faster yolk absorption could be related to more organ maturation, in chicks hatching later in the hatch window (Van de Van, 2013). Early-fed chicks indicated significantly lower relative yolk sac weight compared to later-fed chicks at different ages, confirmed previous reports (Noy *et al.*, 1996; Wang, 2016). The authors argued that the yolk utilization was more rapid in fed chicks than in fasted chicks and suggested that the transfer of yolk can be facilitated by the intestinal motility of fed chicks.

The relative liver and intestinal weights as the percentage of body weight were significantly higher in later-hatched chicks, which is in line with Van de Ven *et al.* (2013) and indicates that later-hatched chicks are more matured than early-hatched chicks. It could also be related to increasing AMPK activity in later-hatched chicks, as explained for the body weight before. Similarly, birds that had access to feed immediately after hatching exhibited more rapid development of the liver and intestines during the early days of post hatch that confirmed previous reports (Van de Ven *et al.*, 2013; Wang, 2016).

Physiological and physical stressors, such as fasting and water deprivation, increase the H/L ratio in chickens (Cravener *et al.*, 1992; Weimer, 2018). The higher H/L ratio observed in the present work confirmed again that the longer dietary-deprived period in hatcheries can increase stress in newly hatched chicks, increase early mortality, and have long-lasting effects on growth performance (Juul-Madsen *et al.*, 2004; Weimer, 2018).

Temperature is one of the major factors and is essential to promote the highest hatchability and the best hatchling quality. The embryonic development is delayed in temperatures below optimum and retarded embryo development in temperatures above optimum (Decuypere & Mitchels, 1992; Wijnen *et al.*, 2020; Willemsen *et al.*, 2010). The results of the second experiment demonstrated that when eggs were incubated in hatcher A with a constant air temperature of 37.5ºC, their eggshell temperature was determined at 38.5ºC. While, in hatcher B, the eggshell temperature was optimized at 37.5ºC, but its air temperature showed 36.5ºC. This means that in both hatchers, the eggshell temperatures were 1ºC higher than their air temperatures. Eggshell temperature is optimized by embryonic heat production and heat transfer capacity of the air, which also depends on the metabolic activity of embryos, especially in the last three days in the hatcher (Decuypere & Mitchels, 1992; Ipek *et al.*, 2014).

Regarding data presented in Table 5, the hatchability was delayed in hatcher B than in hatcher A up to 490 h of incubation. Then, the hatchability increased from 490 h onward in hatcher B compared to hatcher A, confirmed previous reports (Decuypere & Mitchels, 1992; Maatjens *et al.*, 2016a, 2016b), indicating that the hatching time is delayed (and shifted here) to the last hour of incubation by reducing of incubation temperature. However, the final hatchability was lowered (96.6% versus 98.3%) in hatcher B when compared to hatcher A. This was accompanied by increased embryonic mortality (1.7%) and decreased percentage of chick quality score (0.6%) in hatcher B than in hatcher A (Table 5). It means that the percentage of second-grade chickens increased when hatchery temperature decreased.

Except for the relative heart weight in the external piping embryos that was significantly higher in hatcher B than in hatcher A, no more significant hatching effect was found on the organ weights of post-hatch chicks in this study. The heart is an organ that is most affected by abnormal incubation temperature (Ipek *et al.*, 2014); however, in the present work, the abnormality of heart weight returned to the normal weight on days 1 and 5 of post-hatch chicks.

In conclusion, the present study indicated that early-hatched chicks in the hatching window seemed to be less mature during hatching compared to later-hatched chicks, based on lower absolute body weight and internal organ weights. The lower yolk uptake in early-hatched chicks (especially in fasted chicks) compared to later-hatched chicks indicated a metabolic adaptation to preserve nutrition during the fasting period. More organs development in later-hatched and early-fed (LhEf) chicks compared to early-hatched chicks is proven within the same feeding birds, showing a significant interaction (Table 2), and indicating late-hatched chicks to be more sensitive to late feeding compared to early-hatched chicks.

The second experiment, as a pilot study, was conducted to investigate the effect of different temperatures, mainly eggshell temperature profiles, in the hatchery on embryonic development. In this part, a clear result was observed in hatcher B, when the hatching window was shorted, and also the majority of hatchability was shifted to the end of hatching times (at 490 h of incubation onward). This may have implications in combination with early or retarded feeding after hatching and should be examined in further studies.

Acknowledgments

Financial support was provided by the research committee of Tehran University, Faculty of Veterinary Medicine. Department of Biosystems, KUL, Belgium, is appreciated for their kind support.

Conflict of Interest

The authors declared no conflict of interest.

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Iranian Journal of Veterinary Medicine
10.22059/IJVM.2021.322869.1005170
Abstracts in Persian Language
ISSN Online 2252-0554

مجله طب دامی ایران، ۱۴۰۰، دوره ۱۵، شماره ۳، ۲۷۵-۲۸۵

تاثیر پارامترهای هچری و زمان دسترسی جوجه به جیره غذایی بر وزن جوجه و ارگان‌های داخلی آن

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(دریافت مقاله: ۱۵ فروردین ماه ۱۴۰۰، پذیرش نهایی: ۱۱ خرداد ماه ۱۴۰۰)

چکیده

زمینه مطالعه: در جوجه‌کشی‌های تجاری معمولا جوجه‌های تازه هچشده گاهی تا مدت ۷۲ ساعت دسترسی به آب و غذا ندارند.

هدف: تاثیر متقابل پارامترهای زمان هچ و زمان دسترسی جوجه به جیره غذایی روی رشد جوجه است که در دو آزمایش مکمل هم بررسی شد.

روش کار: در آزمایش اول، تعداد ۳۰۰ قطعه جوجه که نیمی از آن هچ زود هنگام و نیمی دیگر هچ دیر هنگام بودند و اینکه بلافصله و یا با تاخیر ۴۸ ساعت بعد هچ به غذا دسترسی داشتند، به ۴ گروه مساوی تقسیم و پرورش داده شدند. وزن جوجه و وزن ارگان‌های داخلی آنها تا سن ۷ روزگی بررسی شد. در آزمایش دوم، نیز تعداد ۳۷۰ عدد تخم مرغ که تا روز ۱۸ در یک ستر انکوبه شده بودند به‌صورت مساوی به دو هچر که به لحاظ درجه حرارت متفاوت بودند، منتقل شدند. در این آزمایش پارامترهای هچ، وزن بدن جوجه و وزن ارگان‌های داخلی آنها تا ۵ روزگی بررسی شدند.

نتایج: نتایج نشان داد که وزن‌گیری جوجه‌های دیرتر هچشده نسبت به جوجه‌های زودتر هچشده به‌صورت معنی‌داری (P<۰/۰۵) بیشتر بوده و به همین نسبت جذب زرده بهتری داشتند و نیز وزن کبد و روده (P<۰/۰۰۱) آنها نسبت به وزن بدن تا سن دو روزگی، بیشتر بوده است. از طرفی وزن جوجه هایی که بلافاصله بعد هچ به دان دسترسی داشتند نسبت به جوجه هایی که با تاخیر ۴۸ ساعته به دان دسترسی پیدا کردند، تا هفت روزگی به‌صورت معنی داری (P<۰/۰۰۱) بالاتر بوده است. ضمن اینکه جذب زرده در این جوجه ها هم سریع تر (P<۰/۰۰۵) اتفاق افتاد و نسبت وزن اندام‌های داخلی آنها هم بالاتر بوده است.

آزمایش دوم موید این است که در هچر A یا کنترل، وقتی درجه حرارت محیط داخلی دستگاه ۳۷/۵ درجه سانتی‌گراد تنظیم گردید، حرارت پوسته تخم مرغ آن ۳۸/۵ درجه سانتی‌گراد تنظیم شد. در مقابل، در هچر B هنگامی که درجه حرارت پوسته تخم مرغ ۳۷/۵ درجه تنظیم گردید، درجه حرارت محیط داخلی این هچر ۳۶/۵ درجه سانتی‌گراد، و یک ۱ درجه کمتر را نشان داد. با کاهش یک درجه از حرارت پوسته تخم مرغ هچ جوجه تا ساعت ۴۹۰ از دوره انکوباسیون در هچر B به تاخیر افتاد ولی میزان هچهای ساعت‌های بعدی این هچر نسبت به هچر A افزایش پیدا کرد.

نتیجه‌گیری نهایی: مطالعه حاضر نشان داد که جوجه‌هایی که دیر هچ شدند و مخصوصا آنهایی که زودتر به دان دسترسی داشتند از رشد و تکامل بهتری برخوردار بودند. در آزمایش دوم، کاهش یک درجه از دمای هچر سبب گردید که زمان هچ جوجه با تاخیر و اکثر هچ به آخر دوره هدایت گردد.

واژه‌های کلیدی: جوجه، پوسته تخم مرغ، جیره غذایی، هچ ، درجه حرارت

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