



The Effect of Egg Storage Positioning on Hatching, Growth Performance, Carcass, and Welfare Traits in Broiler Chickens

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Abstract. This study investigated the effect of egg storage positioning on hatching, growth, carcass, and welfare traits in broiler chickens. A total 90 eggs of broiler breeders at 33 wk were used. The experimental groups consisted of eggs stored with either the broad end-up (BEU) or the narrow end-up (NEU) for 7 d. Each group consisted of with 45 eggs. The average temperature and humidity of the storage room was 20 ° C and 70%, respectively. The average egg weight before storage was 59.49±0.43 (g) and 61.00±0.43 (g) for BEU and NEU, respectively. However, the mean values for the egg weight after storage was 59.10±0.42 (g) for BEU and 60.53±0.42 (g) for NEU. The hatchability of fertile eggs was 97.56 % for NEU and 97.67 % for BEU. While the hatchability of set eggs was 93.33% for BEU and 88.89% for NEU. The FI, FCR, BW, BWG, TI and NOI did not significantly vary between the groups ($P>0.05$). While the CCY was significantly higher in BEU, the SP-W was significantly higher in NEU ($P<0.05$). The BR nearly reached a significant level, higher in BEU than in NEU ($P=0.057$). The temperature of the footpad nearly reached a significant level, higher in BEU compared to NEU ($P=0.058$). Storing eggs with the NEU may have the potential to reduce stress and fear in broiler chickens.

Keywords: Broiler, Storage, Growth, Carcass, Welfare

1 Introduction

The global rise in demand for chicken meat and eggs [1, 2] has led to an exponential expansion in the growing or production of layer chickens for eggs and broiler chickens for meat. The lack of religious censure and the low cost of chicken meat and eggs are the main causes of the increased demand and consumption [3, 4, 5]. Furthermore, [6] noted that rising incomes and standards of living have led to a huge growth in the demand for poultry goods, particularly eggs. Breeder firms have expanded their capacity, increasing the quantity of hatching eggs produced daily, monthly, and annually in order to guarantee a consistent supply of chicken meat and eggs.

Chicks are hatched in batches, and hatching eggs are stored for a specific amount of time because many hatcheries have limited capacity that are lower than the quantity of hatching eggs they receive [7]. Commercial hatcheries frequently store eggs before incubation, and it is well recognized that hatching traits are influenced by storage temperature, humidity, turning, and storage length [8]. Numerous



techniques have been used to reduce the detrimental effects of storage on the quality of eggs, the development of the embryo, hatching, and the performance of broiler chickens after hatching. Nevertheless, there hasn't been enough use of storing hatching eggs with the narrow end facing up.

It is common practice to keep both table and hatching eggs with the broad end facing up with the growing embryo underneath the pores (air cells). Because the broad-end of eggs contains the biggest and highest pores, moisture evaporates from it more quickly. Egg quality, embryonic development, hatching procedures, and post-hatch chick quality attributes may all be impacted by extreme dehydration of the interior components of eggs. The storing of eggs with the broad-end or narrow-end up or in a horizontal posture has produced conflicting findings, despite the paucity of available literature. For example, hatching eggs stored horizontally, with the narrow-end up, or broad-end up did not significantly differ in weight before incubation and at ED 21 [9]. Additionally, [10] found that the weight of the eggs after storage was similar between eggs stored with the narrow-end up and those that were stored broad-end up. However, [11] found that chicken eggs stored with the broad end up lost more weight at 7 and 14 days of storage than those stored with the narrow end up.

Therefore, this study investigated the effect of egg storage positioning on hatching, growth performance, carcass, and welfare traits in broiler chickens.

1.1 Animal material, experimental groups and incubation conditions

A total of 90 hatching eggs of broiler breeders at 33 weeks of age (wk) were used in this study. The eggs were first weighed using a scale of 0.1g precision and divided into 2 groups. The groups consisted Group A (Eggs stored with the broad-end up, normal) and Group B (Eggs stored with the narrow-end up). The eggs of the various groups were stored for 7 days (d) with an average temperature and humidity of 18 °C and 75%. The egg weight before storage was 59.49 ± 0.43 g and 61.00 ± 0.43 g for groups A and B, respectively. After storage, the eggs were incubated under standard conditions (37.8 °C and 65% humidity) between ED 0 and 18. At ED 18, candling was conducted and fertile eggs were transferred to the hatcher with a temperature and humidity of 37.5 °C and 70%, respectively.

At hatch, all the chicks were weighed using a scale with 0.1 g precision, and all the unhatched eggs were broken to actually confirm embryos died. The hatchability of set eggs (HSE), hatchability of fertile eggs (HFE), and embryonic mortality (EM) were evaluated using the formula below.



$$\text{HSE}\% = \frac{\text{Number of hatched chicks}}{\text{Total number of eggs set}} \times 100 \quad (1)$$

$$\text{HFE}\% = \frac{\text{Number of hatched chicks}}{\text{Total number of fertile eggs}} \times 100 \quad (2)$$

$$\text{EM}\% = \frac{\text{Number of dead embryos}}{\text{Total number of fertile eggs}} \times 100 \quad (3)$$

1.2 Post-hatch housing conditions and feeding

The chicks from the various experimental groups were reared for six wk in a litter system with 3 replicates per group each having 10 chicks. Feed and water were provided *ad libitum*. At 1 wk of age, the brooding temperature was 30-33°C. The temperature was gradually reduced to 22-24 °C between 2 and 6 wk of age. The photoperiodic lightning used was 21 hours of light and 3 hours of darkness. The composition of the diet used in this study is given in Table 1.

Table 1. Nutritional composition of the diet used in this experiment

Composition	Feed type		
	Starter diet (1-11 d)	Grower diet (12-24 d)	Finisher diet (28-42 d)
Lysine (%)	1.44	1.15	1.05
Methionine (%)	0.56	0.47	0.47
Metabolic energy (kcal/kg)	3000	3200	3200
Vitamin D3 (IU/kg)	2000	2000	2000
Vitamin A (IU/kg)	10,000	10,000	10,000
Crude protein (%)	23	19.5	19.5
Crude cellulose (%)	3.6	3.6	3.07
Crude fat (%)	5.4	7.2	7.2
Crude ash (%)	6.3	5.3	5.3
Calcium (%)	3.96	0.78	0.78
Phosphorus (%)	0.48	0.39	0.39
Sodium (%)	0.16	0.16	0.16
Manganese (mg/kg)	80	80	80
Zinc (mg/kg)	60	60	60



Cobalt (mg/kg)	0.5	0.5	0.5
Selenium (mg/kg)	0.15	0.15	0.15
Iodine (mg/kg)	2	2	2
Iron [iron sulphate monohydrate] (mg/kg)	60	60	60
Copper [copper sulphate pentahydrate] (mg/kg)	5	5	5

1.3 Evaluation of performance, stress, fear, and carcass parameters

The body weight (BW) was measured weekly using a scale with a precision of 0.1 g. The feed intake (FI) was measured by subtracting the leftover feed at the end of a particular week from the feed given at the beginning of that week. The weekly body weight gain (BWG), feed conversion ratio (FCR), and FI were evaluated using the formula below.

$$BWG = (\text{Body weight of subsequent weeks} - \text{body weight of previous weeks}) \quad (4)$$

$$FI = (\text{Feed given at the beginning of a particular week} - \text{feed left at the end of that week}) \quad (5)$$

$$FCR = \frac{\text{Feed intake (g)}}{\text{Body weight gain (g)}} \quad (6)$$

At 5 wk of age, the footpad, beak, comb, and metatarsal temperature of 4 chickens per treatment was identified using a WOHLER ST-D2 ($\pm 0.3^\circ\text{C}$) infrared thermometer under post-hatch heat stress conditions ($30 \pm 1^\circ\text{C}$, 30%RH). The cloacal temperature was identified by inserting an MT101 clinical thermometer ($\pm 0.1^\circ\text{C}$) 3cm inside the cloacal for 20-30s [5].

In this trial, the measure of fear was tonic immobility (TI). For TI responses, a total of 12 birds from each group were examined. The hens were held on their backs on a table by the experimenter to induce tonic immobility. The bird's head was closed for 15 seconds with the left hand while a little force was applied to the chest with the right. The experimenter held the birds upside-down for 15 seconds while applying light pressure to the sternum. Then, gently and delicately, the experimenter took their hand away from the bird. If the bird stayed immobile after the 15s restraint was initiated, the TI duration was recorded from that moment using a stopwatch until the bird righted itself. Following five unsuccessful



attempts at 15-second restraint, the birds' TI was reported as zero (0). 300s was the maximum TI duration. A separate chamber inside the manufacturing plant was used for the tonic immobility test.

At 6 wk of age, chickens whose live weights were close to the average live weight of each replicate were slaughtered. At slaughter, the weight of the hot carcass, heart, spleen, gizzard, and liver were determined using a scale with 0.01 g precision. The hot carcass was then stored in a refrigerator at +4 °C for 24 hours. After the 24-hour cold storage, the weight of the cold carcass, abdominal fat, and carcass parts (breast, thigh, wings, and back) were identified with a scale of 0.01 g precision. The cold and hot carcass yield were evaluated according to the formula below [12, 13].

$$\text{Hot carcass yield (\%)} = \frac{\text{Hot carcass weight (g)}}{\text{Slaughter weight (g)}} \times 100 \quad (7)$$

$$\text{Cold carcass yield (\%)} = \frac{\text{Cold carcass weight (g)}}{\text{Slaughter weight (g)}} \times 100 \quad (8)$$

1.4 Statistical analysis

The normality test and test of homogeneity of the data were conducted using Shapiro-Wilk and Levene's tests, respectively. It was confirmed that the data showed normal distribution. After confirming the normality of the data, the analysis of variance (ANOVA), independent samples t-test was applied to the data. The *p-value* was set at $P \leq 0.05$. The statistical software package JMP 18 (SAS, 2017) was used for data analysis.

2 Results and Discussion

The effect of egg storage position of on egg weight, hatchability, embryonic mortality, and chick weight are presented in Table 2. The EW-AS and at ED 18 was significantly higher in Group B than in Group A ($P < 0.05$) and it was speculated that the storage of eggs with the broad-end up might have increased the eggshell conductance or accelerated the stimulation of the mechanism involved in the gaseous exchange between the egg and its environment. This contradicts the findings of [9], who reported that hatching eggs of chukar partridge (*Alectoris chukar*) stored with broad-end up, narrow-end up or in a horizontal position did not significantly vary in terms of egg weight before incubation and at ED 21. In addition, [10] and [14] also reported that eggs stored with either the broad or the narrow-end up did not vary in terms of EW-AS. The difference in results could be related to the species, hen age, or duration of



storage. The Ew-L did not significantly differ between the groups which aligns with the findings of [9]. We therefore speculate that the storage duration or position in the current study was not detrimental enough to cause significant changes in Ew-L between the groups.

The HSE and HFE was higher in in Group A than in Group B and we speculate that the storage of eggs with the narrow-end up might have negatively influenced the mechanisms, hormones or genes involved hatching processes of chicks. Our results contradict the findings of [9] and [14] who reported higher hatchability in eggs stored with the narrow-end up compared to those stored with the broad-end up.

The EM was higher in Group B indicating that the storage of eggs with the narrow-end up might have facilitated or increased the apoptotic death of embryonic cells leading to higher EM. This contradicts the findings of [9] and [14] who reported lower EM in eggs stored with the narrow-end up compared to those stored with the broad-end up.

The chick weight at hatch did not significantly vary between the experimental groups and we speculate that the storage of eggs at different positions could not influence embryonic or satellites cells, the primary responsible for muscle growth development however, this result disagree with the findings of [15] who significantly identified higher chick weight at hatch in chicken eggs stored with narrow-end up.

The effect of egg storage positioning on growth performance traits in broiler chickens is presented in Table 3. This study is the first to examine the effect of egg storage position on BW, BWG, FI, and FCR however, the performance traits examined did not significantly vary between the experimental groups ($P>0.05$). It is possible that the different storage positions or the duration of storage did not have any significant effect on of embryonic development, intestinal development and health and other factors responsible for the control of voluntary feed intake in birds after hatch.

The effect of egg storage positioning on carcass and internal organs in broiler chickens Table 4. The CCY was significantly higher in Group A than in Group B ($P<0.05$) which probably due to the higher cold carcass weight of the birds in that group. However, the SP-W was significantly higher in Group B than in Group A ($P<0.05$) indicating the storage of eggs with the narrow-end up might have facilitated or enhanced the activity of the cells, hormones, genes or mechanisms involved in the growth and development of immune organs. The remaining carcass and organ traits did not significantly vary between the experimental groups ($P>0.05$). The effect of egg storage positioning on stress and fear



responses in broiler chickens is given in Table 5. The breast, metatarsal, footpad, wattle, comb, rectum, duration of tonic immobility, and number of inductions did not significantly vary between the experimental groups ($P>0.05$) indicating that the egg storage position did not alter the mechanisms involves in the activation of fear and stress in chickens.

Table 2. The effect of egg storage position of on egg weight, hatchability, embryonic mortality, and chick weight at hatch

Groups	EW-AS (g)	EW-ED 18 (g)	Ew-L (ED 0-18) (%)	HSE (%)	HFE (%)	EM (%)	Chick weight (g)
A	59.10±0.42	54.29±0.40	8.67±0.16	93.33	97.67	Şub.33	43.35±0.35
B	60.53±0.42	56.00±0.41	8.73±0.16	88.89	97.56	Şub.44	43.97±0.35
<i>P-value</i>	0.019*	0.004*	0.781	-	-	-	0.209

Group A (Eggs stored with the broad-end up, normal), Group B (Eggs stored with the narrow-end up), EW (Egg weight), AS (After storage), EWL (Egg weight loss), HSE (Hatchability of set eggs), HFE (Hatchability of fertile eggs), EM (Embryonic mortality), ED (Embryonic day).

Table 3. The effect of egg storage positioning on growth performance traits in broiler chickens

Group s	Age of broilers (wk)						
	1	2	3	4	5	6	
BW (g)	A	173.93±2.12	459.77±3.10	950.10±51.51	1525.17±24.72	2451.27±38.96	3145.72±54.87
	B	174.34±2.12	462.03±3.10	935.17±15.51	1520.73±24.72	2403.17±38.96	3115.93±56.87
	<i>P-value</i>	0.868	0.607	0.499	0.899	0.382	0.708
BW G (g)	A	130.55±4.90	285.87±10.79	490.33±10.83	575.07±12.83	926.10±27.86	696.07±25.66
	B	130.46±4.90	287.60±10.79	473.13±10.83	585.57±12.83	901.80±27.86	686.93±25.66
	<i>P-value</i>	0.990	0.915	0.324	0.594	0.571	0.814
FI (g)	A	1802.00±29.56	5955.00±155.43	6786.67±114.01	9000	13246.67±333.65	11336.67±371.75
	B	1824.67±29.56	5702.67±155.43	6477.67±114.01	9000	12779.67±333.65	10955.67±371.75
	<i>P-value</i>	0.616	0.315	0.128	-	0.378	0.509
FCR	A	1.38±0.06	2.09±0.01	1.38±0.03	1.57±0.04	1.43±0.06	1.69±0.15
	B	1.40±0.06	2.00±0.01	1.37±0.03	1.54±0.04	1.42±0.06	1.67±0.15
	<i>P-value</i>	0.818	0.552	0.743	0.532	0.881	0.952

Group A (Eggs stored with the broad-end up, normal), Group B (Eggs stored with the narrow-end up), BW (Body weight), BWG (Body weight gain), FI (Feed intake), FCR (Feed conversion ratio), wk (week).



Table 4. The effect of egg storage positioning on carcass and internal organs in broiler chickens

Groups	SW (g)	HCW (g)	HCY (%)	CCW (g)	CCY (%)	TH-W (g)	BR (g)	WG-W (g)	NK-W (g)
A	3213.33	2566.56	79.89	2518.25	± 78.38	668.06	1194.63	198.85	181.56
	±	±	±	33.67	±	±	±	±	±
B	41.42	34.09	0.27		0.27	14.27	19.36	Şub.54	Haz.15
	3216.31	2545.69	79.34	2480.38	± 77.33	672.50	1140.44	198.13	191.81
P-value	±	±	±	33.67	±	±	±	±	±
	41.42	34.09	0.27		0.27	14.27	19.36	Şub.37	Haz.15
	0.959	0.668	0.158	0.433	0.009*	0.827	0.057	0.839	0.248
Groups	BK-W (g)	HT-W (g)	L-W (g)	G-W (g)	SP-W (g)	B-W (g)	PRO (g)	AF-W (g)	
A	257.13	16.50	57.16	52.09	Şub.66	May.24	Eyl.99	27.60	
	±	±	±	±	±	±	±	±	
B	May.89	0.77	Oca.95	Şub.63	0.20	0.41	0.48	Oca.63	
	258.81	15.88	59.89	55.12	Mar.33	May.35	Eki.39	27.26	
P-value	±	±	±	±	±	±	±	±	
	May.89	0.82	Oca.83	Şub.47	0.19	0.39	0.43	Oca.68	
	0.841	0.585	0.317	0.407	0.024*	0.854	0.539	0.885	

Group A (Eggs stored with the broad-end up, normal), Group B (Eggs stored with the narrow-end up), SW (Slaughter weight), HCW (Hot carcass weight), HCY (Hot carcass yield), CCY (Cold carcass yield), TH-W (Thigh weight), BR (Breast weight), WG-W (Wing weight), NK-W (Neck weight), BK-W (Back weight), HT-W (Heart weight), L-W (Liver weight), G-W (Gizzard weight), SP-W (Spleen weight), B-W (Bursa Fabricus), PRO (proventriculus)AF-W (Abdominal fat weight).

Table 5. The effect of egg storage positioning on stress and fear responses in broiler chickens

Group	Breast (°C)	Metatarsal (°C)	Footpad (°C)	Wattle (°C)	Comb (°C)	Rectum (°C)	No Induction (minute)	TI Duration (minute)
A	36.89±0.11	37.32±0.17	36.46±0.18	36.46±0.20	35.87±0.15	41.10±0.01	1.50±0.14	3.53±0.43
B	37.09±0.11	37.48±0.17	35.98±0.18	36.18±0.20	35.81±0.15	41.22±0.01	1.18±0.14	2.80±0.43
P value	0.217	0.479	0.058	0.331	0.777	0.306	0.107	0.234

Group A (Eggs stored with the broad-end up, normal), Group B (Eggs stored with the narrow-end up).

3 Conclusion

In the current study, it was concluded that the storage of eggs with the narrow or broad-end up could be beneficial for egg weight, immune organs or carcass traits without any negative effect on performance and welfare traits.

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