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Breeder age and hatching egg storage duration: effects on post-hatch performance of FUNAAB- α broiler chickens

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Abstract

This trial was designed to evaluate the influence of hatching egg storage length and broiler breeder hens' age on post-hatch growth performance and physiological responses of FUNAAB-α chickens. Five hundred fertile eggs from each of 60 and 32-wk-old FUNAAB-α breeder hens were collected and assigned to five storage durations (0, 3, 7, 11, and 15 d). The hatching eggs were incubated using the conventional protocol. Data were collected on the growth performance and physiological responses. A 2 × 5 factorial design was used for the experiment. The results revealed that there was a decline in the final body weight in chickens from eggs of 15 and 11 d storage compared to the chickens from 7, 3, and 0 egg storage days. Chickens of 32-week-old breeder hens had higher ($P < 0.05$) mean corpuscular volume, white blood cell, heterophil, and pack cell volume values compared to 60-week-old breeder hens. Hatchlings from 60-week-old breeders had a higher liver percentage (3.0% yolk-free body weight [YFBW]) than those from 32-week-old breeders (2.8% YFBW). It was concluded that an extended storage duration of 15 d adversely affected the carcass traits and growth performance of chickens from egg storage above seven days.

Lay Summary

Hatching eggs may be kept in storage for some time before they are set in the incubator. This is often the case in commercial hatcheries, where keeping the eggs for a few days is the only way to get multiple chicks to hatch concurrently. This study assessed how the age of the breeder and egg storage affected the FUNAAB-α broilers' physiological responses and growth performance. The study revealed that storing eggs for more than 7 d has a negative impact on the growth performance and carcass characteristics of chickens.

Key words: age, breeder, FUNAAB-α broiler, growth, storage

Introduction

In commercial hatcheries, storing fertilized eggs before incubation is a standard method to synchronize hatchings and organize operations in poultry production. It allows for some adaptability to needs and makes hatching synchronization easier (Tona et al., 2022). In addition, due to seasonal fluctuations in demand, hatching eggs must be stored for extended periods. In commercial hatcheries, getting many chicks to hatch simultaneously is frequently only possible after storing the eggs for a few days. Furthermore, the duration of egg storage can differ because of the poultry industry's fluctuating market demands for day-old birds and the maximum capacity of hatcheries (Fasenko, 2007). Both negative and positive effects could result from storing eggs before incubation (Brake et al., 1997; Tona et al., 2022). It has been demonstrated that hatchability rates and chick quality are negatively connected with the amount of time eggs are stored (Dymond et al., 2013). It is well known that embryonic development is significantly influenced by the mechanical, morphological, and physical properties of eggs (Ghane et al., 2015). Eggs stored for more than 1 wk have a negative effect on hatchability because of changes in the embryo's metabolism (Fasenko et al., 2002). Compared to embryos from eggs held for 4 d storage, the embryonic metabolic processes from eggs' 15-d storage progressed more slowly (Fasenko et al., 2002). Day-old chicken quality is correlated with egg quality, which is influenced by a number of factors, including breeder age, and the length of time eggs are stored (Vargas et al., 2009). For broilers to have a healthy start and growth potential, the quality of the day-old chicks is important (Meijerhof, 2009).

Breeder age is one of the aspects that hatchery management must take into account, as it might impact production rates (Tona et al., 2001). Flock age is one important factor influencing the amount of albumen and yolk in eggs (Nangsuay et al., 2011). As hens age, their albumen and yolk weights fluctuate. Additionally, as the hen ages, there is a higher increment in yolk than albumen (Peebles et al., 2000). In correlation with flock age, egg weight has a curvilinear function that achieves a plateau near the conclusion of the laying cycle (Nangsuay et al., 2011). Hatching eggs from

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old breeders contain different components that can alter the embryonic death rate and, in turn, the hatching percentage (Peebles et al., 2001; Tumová and Gous, 2012; Manyeula et al., 2021). In order to minimize gas exchange and moisture loss, which can impair early embryonic development and lower subsequent hatching rates, breeders begin the laying process by producing eggs with thick shells, few pores, and dense albumen (Araujo et al., 2017). Eggshell conductance, which is important for O2 and CO2 exchanges throughout embryonic development, is influenced by breeder age (Ar and Rahn, 1985; O'Dea et al., 2004).

Post-hatch performance is also influenced by breeder age and storage time (Kouame et al., 2020; Bilalissi et al., 2022). The findings of Tona et al. (2003) revealed that relative growth was found to have decreased, while Petek and Dikmen (2006) observed that the feed conversion ratio (FCR) increased as egg storage length increased. In contrast, Okur et al. (2018) observed that egg storage length had no effect on post-hatch performances. However, Ipek and Sozcu (2015) found that chickens from younger flocks (33 vs. 62 wk) had higher body weight (BW)s at 7 d of age. They attributed this result to the young flock's hatchlings' advanced intestinal development and higher yolk sac absorption. El Sabry et al. (2015) observed that chickens from older breeders had higher BWs at 35 d of age (49 vs. 32 week). The increased weight of the chicks at hatch in the older breeder flocks was the reason for this variation (Maiorka et al., 2004).

In the tropics, the search for thermotolerant chicken breeds has been ongoing for a while. Native chickens, which make up around 80% of the entire rural chickens, have been shown to be a reliable food security source (Kpomasse et al., 2023; Iyasere et al., 2022). It is well known that native Nigerian chickens serve two purposes in the country's rural and periurban areas: they are raised for meat and eggs (Obanla et al., 2012; Oke et al., 2013, 2014, 2015). Under a traditional family scavenging management system, they are found in great numbers scattered over many agroecological categories (Kpomasse et al., 2023). The recently registered FUNAAB alpha chickens are one of the locally generated breeds in Nigeria that were specifically bred for tropical environments (Adebambo, 2015). There has been a growing interest in FUNAAB alpha chickens by farmers as a replacement for the broiler chickens that are bred for temperate regions owing to their better heat resistance (Wheto et al., 2017; Bamidele et al., 2019; Yakubu et al., 2020). This is because resource-poor poultry producers in less developed nations, who cannot afford a controlled environmental system, engage in poultry production using open-sided housing systems. Despite the potential of the chickens, there is a scarcity of scientific data on the effect of the breeder's age and egg storage duration on the responses of the progenies. It was hypothesized that breeder age and storage duration would impact the hatching and post-hatch growth of FUNAAB-α broilers. Therefore, this study evaluated the effect of egg storage and breeder's age on the growth performance and physiological responses of FUNAAB-α broilers.

Materials and Methods

Experimental Birds

Five hundred hatching eggs each from 60 week (2.98 Kg) and 32 week (2.776 Kg) old FUNAAB-α hens were collected and assigned to five storage durations (0, 3, 7, 11, and 15 d). The hatching eggs were incubated using the conventional protocol. After hatch, the chicks were reared on a deep litter housing system with bedding materials of wood shavings of at about 5 cm depth on the concrete floor. The management protocol of our earlier study (Alo et al., 2023) was adopted.

Experimental Design

The trial was laid out in a 2 by 5 factorial randomized completely block design, including two FUNAAB-α hen ages (60 and 32 wk old) and five storage durations (15, 11, 7, 3, and 0 d) with a total of 10 treatment and four replicate per treatment. Five hundred eggs collected obtained from each of the age groups were assigned 100 eggs each per storage period. The eggs were stored to the precise time of setting.

Storage of Egg and Incubation

At 15 °C and 65% relative humidity, the hatchery cold room was used to store the hatching eggs. The eggs from the various storage durations were placed inside the incubator. The hatching eggs were weighed, marked, and stored for 15, 11, 7, 3, and 0 d, in egg trays with the broad end facing up. There were four duplicates, each containing 25 eggs, and 100 eggs total for each treatment. The eggs were set in an incubator (N.V. Petersime Incubator, Belgium) with a wet bulb temperature of 29.5 °C and a regulated dry bulb temperature of 37.5 °C. The eggs were moved into the hatchers on the 18th d of incubation after they were candled.

Data Collection

Growth Performance

Performance indicators such as feed intake (FI), BWs, weight gain (WG), FI, FCR, mortality rate, and organs' relative weights were determined across the treatment in each replicate throughout the experimental duration.

Feed Intake

FI was measured weekly. The weights of the feed supplied to the birds and the leftovers for each replicate were measured.

$$\text{Total feed intake } (g) = \text{Total feed allocated to birds } (g) - \text{leftover feed}(g)$$

$$\text{Average feed intake} = \text{Feed intake } (g)/\textit{Number of birds}$$

BW Gain

At the start of the experiment, each bird's BW was recorded separately, and then at the end of each week. The mean weights of all the birds were calculated once they were weighed using a weighing balance. By deducting the bird's prior weight from its current weight, the WG of the birds was determined.

Feed Conversion Ratio

Records of weekly feed consumption and WG were used to calculate the FCR. The FCR was determined as the ratio of the feed consumed to the weight gained.

Hematology and Serum Biochemical Parameters

Two chickens per replicate were chosen for serum biochemical and hematological parameters at week 12 of the experiment. Five milliliters of blood were drawn from the wing veins for testing. Two milliliters of blood were collected into tubes preheated with ethylene diamine tetra acetic acid. The samples were used to determine hematological indices including the red blood cell (RBC)s, white blood cells, hemoglobin, hematocrit, platelet count, granulocytes, eosinophils, basophils, and lymphocytes. These hematological indices were analyzed with the use of a fully Mindray BC-2,800 analyzer. To avoid inter-assay variability, each hematological parameter was run in the same assay in order.

The remaining (3 mL) blood samples were dispensed into plain tubes and were made to separate into their components in order to conduct serum biochemistry. The serum was separated from the remaining cellular components using a pipette and placed into an Eppendorf tube for serum biochemical indices like albumin, total protein, aspartate transaminase (AST), globulin, glucose, cholesterol, T3, and T4 were determined.

Hatchlings Organs' Weights and Carcass Evaluation at Week 12

At hatch, four birds per replicate of approximately average weight were weighed and euthanized. The residual yolk, yolk-free body weight (YFBW), and internal organs were recorded. The weights were expressed relative to YFBWs. At 12 week of age, four birds per replicate of approximately average weight were slaughtered. Each bird was weighed, slaughtered, bled, scalded, de-feathered, and eviscerated. The weights of cut parts were recorded as a percentage of the live weights at slaughter. This includes the breast meat, gizzard, drumstick, shank, thigh, wing, neck, head, internal organs (heart, liver, and proventriculus), and lymphoid organs from the birds (spleen and bursa of Fabricius).

Statistical Analysis

The data obtained were analyzed in a 2-way ANOVA and the means were separated using Tukey's HSD using the SAS statistical package. $P < 0.05$ was the probability level used.

Statistical model $Yijkl = \mu + Si + Bj + (SB)ij + \Sigma ijk$, where: Yijkl is the value of the dependent variable, μ is the population mean, Si is the storage days of eggs (i = 0, 3, 7, 11, and 15 d), Bj is the Breeder flock age (j = 32 and 60 week age), SBij is the effect of the interaction between Storage days and Breeder flock age, and Σijk is the residual error.

Results

Post-hatch Performance

The effect of egg storage duration and the breeder hens' age on post-hatch performance parameters in FUNAAB-α broilers is presented in Table 1. The initial weight of chicks was higher ($P < 0.05$) in the 60-week-old breeder (38.3 g) than in the 32-week-old breeders (33.3 g) but was not affected by storage duration. Egg storage duration significantly ($P < 0.05$) influenced final BW (FBW), FI, WG, and FCR. The FBWs and the BW gain of the chickens of the eggs from the older breeders stored for 0, 3, and 7 d were higher than the chicks from the other treatment groups. The lowest FBWs were recorded in the chickens from the eggs old and young breeders stored for 15 d. Chicks from eggs stored for 7, 3, and 0 d had better FCR than chicks stored for 11 and 15 d. The broiler chickens from 7, 3, and 0 d egg storage duration also had similar FI but were significantly lower for 11 and 15 d storage. Birds from unstored eggs had the lowest FI (7,520.9 g), while birds from eggs stored for 11 d had the highest FI (7,719.1 g).

Hatchling weights of the chicks from the older breeders' eggs (60 wk) stored for 0, 3, 7, and 11 d were higher than the chicks from younger breeder hens' eggs (32 week) stored for 0, 7, 11, and 15 d. At 12 week, birds hatched from eggs stored for 0, 3, and 7 d from older breeders (60 week) had similar FBW and WG but were significantly higher than 11, 15 d storage birds from younger breeder (32 week) across all storage duration. Similar FI was also observed in birds of eggs stored for 15 and 11 d in both breeder ages but was higher ($P < 0.05$) than other storage durations. A better FCR was observed in birds hatched from unstored eggs (2.4) of the 60-week-old breeder, while birds from 15 d egg storage from both breeder ages had the least FCR (2.7).

Hematological Indices

The impact of egg storage duration and the age of breeders on hematological parameters in FUNAAB-α broilers is presented in Table 2. The birds of 32-week-old hens had higher ($P < 0.05$) packed cell volume (PCV), white blood cell, heterophil (HET), and mean corpuscular volume (MCV) values than the 60-week-old breeder hen. However, lymphocytes (LYM) and mean corpuscular hemoglobin concentration data of chickens from 32-week-old breeder hens were significantly lower ($P < 0.05$) than those of 60-week-old breeder hens. Chickens from the control eggs (0 d storage) had a higher ($P > 0.05$) HET count (30.5) than the other storage days. The PCV and Hb counts increased ($P < 0.05$) with protracted storage durations. The chicks of 15, 11, 7, 3, and 0 d egg storage had similar ($P < 0.05$) white blood counts (WBC) counts, which were higher than chickens from unstored eggs (0 d).

Hemoglobin (Hb) counts of chickens from the 32-week-old breeder were similar to those of the 60-week-old breeder across all egg storage duration but were higher than unstored eggs (0 d) from the 60-week-old breeder hen. Chickens hatched from unstored eggs (0 d) of the 32-week-old breeder hens had the highest PCV (37.3), while its 60-week-old breeder counterpart had the lowest PCV (21.3). The eosinophil (EOS) count of chickens hatched from eggs stored for 11 d in the 60-week-old breeder was higher ($P < .05$) than other storage days and those of 32-week-old breeders, which had similar EOS counts. BAS, MCV, and mean corpuscular hemoglobin (MCH) counts were affected ($P < .05$) by storage length and age of breeder interactions. MCV and MCH counts of 60 week old breeder chickens hatched from eggs stored for 11 d were significantly higher than other storage durations (0, 3, 7, and 15 d) and those of 32 week old breeder chickens but only similar to chickens gotten from 15-d egg storage of the 32 week old breeder. However, mean corpuscular hemoglobin concentration counts of 60 week old breeder chickens derived from unstored eggs (0 d) were higher ($P < .05$) than those stored for 3, 7, 11, and 15 d in 32 week old hens across the storage length.

Table 1. Influence of egg storage duration and breeder age on post-hatch performance parameters in FUNAAB-α broiler chickens

	Initial body weight (g)	Final body weight (12 wk; g)	Feed intake (g)	Weight gain (g)	FCR
Age (weeks)					
32	33.3[b]	3,005.0	7,618.7	2,971.8	2.6
60	38.3[a]	3,048.0	7,601.4	3,009.8	2.5
Storage (days)					
US	36.4	3,075.0[a]	7,520.9[b]	3,038.6[a]	2.5[c]
3DS	36.5	3,075.6[a]	7,546.6[b]	3,039.1[a]	2.5[c]
7DS	35.5	3,079.4[a]	7,555.6[b]	3,043.9[a]	2.5[c]
11DS	35.6	2,983.1[b]	7,719.1[a]	2,947.5[b]	2.6[b]
15DS	34.8	2,919.4[c]	7,707.9[a]	2,884.6[c]	2.7[a]
Age × storage					
32 × US	33.3[c]	3,021.3[bc]	7,537.0[bc]	2,988.0[bc]	2.5[c]
32 × 3DS	34.3[bc]	3,043.8[b]	7,540.5[bc]	3,009.5[b]	2.5[c]
32 × 7DS	32.8[c]	3,047.5[b]	7,573.0[b]	3,014.8[b]	2.5[c]
32 × 11DS	32.8[c]	2,992.5[cd]	7,723.8[a]	2,959.8[cd]	2.6[b]
32 × 15DS	33.3[c]	2,920.0[e]	7,719.3[a]	2,886.8[e]	2.7[a]
60 × US	39.5[a]	3,128.8[a]	7,504.8[c]	3,089.3[a]	2.4[e]
60 × 3DS	38.8[a]	3,107.5[a]	7,552.8[bc]	3,068.8[a]	2.5[d]
60 × 7DS	38.3[ab]	3,111.3[a]	7,538.3[bc]	3,073.0[a]	2.5[de]
60 × 11DS	38.5[a]	2,973.8[d]	7,714.5[a]	2,935.3[d]	2.6[b]
60 × 15DS	36.3[abc]	2,918.8[e]	7,696.5[a]	2,882.5[e]	2.7[a]
SEM	0.5	11.6	7,610.0	11.5	0.0
P-value					
Age (weeks)	0.001	0.064	0.547	0.098	0.200
Storage (days)	0.801	0.001	0.001	0.001	0.001
Age × storage	0.001	0.001	0.001	0.001	0.001

[a,b,c,d,e]means with different superscripts differ significantly within a column ($P < 0.05$). FCR, feed conversion ratio; g, grams.

Serum Indices

The effect of storage duration and age of breeders on serum biochemical indices in FUNAAB-α broilers is presented in Table 3. Total protein (PROT), albumin (ALB), aspartate transaminase (AST), sodium (Na), potassium (K), and calcium (Ca) levels were higher in chickens gotten from 32 wk old breeder hen than in the 60 wk breeders. However, cholesterol (CHOL) and triglycerides (TRIG) levels were higher in the 60-wk-old breeder chickens. T4 and globulin levels increased with extended storage duration, which declined on 11 d of storage. Also, with 15-d storage duration, reduced levels of potassium, calcium, and ALT were observed, with a spike noticed in 15-d storage. Chicks hatched from unstored eggs (0 d) had higher ($P < 0.05$) concentrated levels of K, Ca, and ALT (6.7, 13.4, and 35.6, respectively), while chickens from eggs stored for 11 d had the lowest concentration (5.1, 9.1, and 26.8, respectively). Albumin concentrations decreased as storage duration increased, but there was a slight increase in 11-d stored eggs, which later dropped in 15-d storage. Aspartate transaminase (AST) concentration also decreased from unstored (0 d) to 7 d of storage, with an increase observed on 11 and 15 d of stored eggs. Cholesterol and triglycerides maintained no ($P < 0.05$) particular trend as storage duration increased. All serum biochemical indices were influenced ($P < 0.05$) by storage and breeder age interaction. Albumin levels decreased with protracted storage durations in chicks from 32-wk breeders, with no particular trend recorded in chicks from 60-wk hens. However, PROT, ALT, AST, cholesterol, Na, K, and Ca levels were higher in unstored eggs (0 d) from the 32-wk-old breeder than in other storage days and eggs from the 60-wk-old breeder across all storage days. Chicken hatched from 7 d stored eggs of the 60 wk old breeder had similar T4 levels with those hatched from 15 d stored eggs of the 32 wk old breeder but were significantly higher than other storage days in both breeder ages. The highest T3 concentration was observed in chickens hatched from 11 d stored eggs of the 32 wk old old breeder (2.1), while chickens from unstored eggs (0 d) of the 60 wk old old breeder had the lowest concentration (0.9).

Relative Organ Weights of Hatchlings

The impact of egg storage duration and the age of breeders on organ weights at hatch in FUNAAB-α broiler chicks is presented in Table 4. Hatchlings from 60-wk-old breeders had higher relative liver weights (3.0% YFBW) than breeders of 32 wk old breeders (2.8% YFBW). YFBW decreased with extended storage duration. Higher chick weight and YFBW were observed in unstored eggs (0 d) compared to other storage durations. Chicks hatched from eggs stored for 7 d also had higher yolk and percentage gizzard weights than 0, 3, 11, and 15 d of egg storage. Percentage heart weight increased with extended storage for up to 15 d, but no particular trend was observed in intestinal weight. However,

Table 2. Influence of egg storage duration and breeder age on hematological parameters in FUNAAB-α broiler chickens

	PCV	Hb	RBC	WBC	HET	LYM	EOS	BAS	MONO	MCV	MCH	MCHC
Age (weeks)												
32	33.3^{a}	11.0	2.9	14.8^{a}	30.7^{a}	68.5^{b}	0.0	0.2	0.5	111.7^{a}	37.5	33.4^{b}
60	31.4^{b}	10.8	2.9	13.7^{b}	28.8^{b}	70.2^{a}	0.1	0.3	0.4	108.5^{b}	37.7	34.9^{a}
Storage (days)												
US	29.3^{b}	10.1^{b}	2.7^{a}	12.8^{b}	30.5	69.5	0.0	0.0^{b}	0.3	104.0^{c}	37.7^{ab}	36.7^{a}
3DS	32.5^{ab}	10.7^{ab}	3.1^{a}	14.2^{a}	29.8	68.5	0.0	0.8^{a}	0.8	106.2^{bc}	34.8^{b}	32.4^{c}
7DS	32.8^{a}	11.0^{ab}	3.0^{ab}	14.9^{a}	29.3	69.8	0.0	0.0^{b}	0.5	113.3^{ab}	37.5^{ab}	33.7^{bc}
11DS	33.3^{a}	11.3^{ab}	2.9^{ab}	14.4^{a}	29.3	70.0	0.3	0.0^{b}	0.3	115.5^{a}	39.0^{a}	33.7^{bc}
15DS	33.8^{a}	11.6^{a}	3.0^{ab}	14.9^{a}	29.3	69.0	0.0	0.4^{ab}	0.5	113.5^{a}	38.9^{a}	34.2^{b}
Age × storage												
32 × US	37.3^{a}	12.2^{a}	3.2^{ab}	14.2^{ab}	31.8^{a}	68.0^{ab}	0.0^{b}	0.0^{b}	0.5	112.1^{bcd}	38.2^{bc}	34.3^{b}
32 × 3DS	30.5^{b}	10.2^{a}	2.8^{abc}	15.1^{ab}	31.5^{a}	67.0^{b}	0.0^{b}	0.5^{ab}	1.0	108.9^{cd}	36.4^{bc}	32.7^{b}
32 × 7DS	32.0^{ab}	10.6^{a}	2.8^{abc}	15.4^{a}	30.5^{ab}	68.5^{ab}	0.0^{b}	0.0^{b}	0.5	114.4^{bc}	37.8^{bc}	33.0^{b}
32 × 11DS	34.0^{ab}	11.3^{a}	3.3^{a}	14.1^{ab}	29.0^{ab}	71.0^{a}	0.0^{b}	0.0^{b}	0.0	103.4^{de}	34.2^{c}	33.1^{b}
32 × 15DS	32.5^{ab}	11.0^{a}	2.8^{abc}	15.1^{ab}	30.5^{ab}	68.0^{ab}	0.0^{b}	0.3^{b}	0.5	119.9^{ab}	40.8^{ab}	33.9^{b}
60 × US	21.3^{c}	8.1^{b}	2.2^{c}	11.5^{c}	29.3^{ab}	71.0^{a}	0.0^{b}	0.0^{b}	0.0	96.0^{e}	37.1^{bc}	39.0^{a}
60 × 3DS	34.5^{ab}	11.1^{a}	3.4^{a}	13.3^{bc}	28.0^{b}	70.0^{ab}	0.0^{b}	1.0^{a}	0.5	103.5^{de}	33.3^{c}	32.2^{b}
60 × 7DS	33.5^{ab}	11.5^{a}	3.1^{ab}	14.4^{ab}	28.5^{ab}	71.0^{a}	0.0^{b}	0.0^{b}	0.5	108.3^{cd}	37.2^{bc}	34.4^{b}
60 × 11DS	32.5^{ab}	11.2^{a}	2.3^{bc}	14.7^{ab}	30.0^{ab}	69.0^{ab}	0.5^{a}	0.0^{b}	0.5	127.5^{a}	43.8^{a}	34.3^{b}
60 × 15DS	35.0^{ab}	12.1^{a}	3.3^{a}	14.8^{ab}	28.0^{c}	70.0^{ab}	0.0^{b}	0.5^{ab}	0.5	107.2^{cd}	37.1^{bc}	34.6^{b}
SEM	0.73	0.21	0.07	0.21	0.28	0.28	0.03	0.07	0.08	1.49	0.54	0.32
P-value												
Age (weeks)	0.018	0.375	0.405	0.001	0.001	0.002	0.094	0.128	0.518	0.027	0.750	0.001
Storage (days)	0.007	0.020	0.052	0.002	0.441	0.160	0.034	0.001	0.227	0.001	0.003	0.001
Age × storage	0.001	0.001	0.001	0.004	0.032	0.003	0.034	0.001	0.227	0.001	0.001	0.001

^{a,b,c,d}means with different superscripts differ significantly within column ($P < 0.05$). PCV, packed cell volume; (g/dL), Hb, hemoglobin (g/dL); RBC, red blood cell(10^3/μL); WBC, white blood cell (10^3/μL); HET, heterophil (%); LYM, lymphocytes (10^3/μL); EOS, eosinophils (10^3/μL); BAS, basophils (10^3/μL); MONO, monocytes; MCV, Mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration (g/dL).

chicks hatched from 11 d of storage had similar intestinal weight with 15 d storage but higher than other storage days (0, 3, and 7 d). Chicks YFBW decreased with prolonged storage duration in both 32 and 60-wk-old hens. Similar residual yolk weight was observed in chickens hatched from eggs stored for 7 d in both breeders but was higher ($P < 0.05$) compared to the other storage durations (0, 3, 11, and 15 d). The highest chick weight (42.0 g) was recorded in the control eggs (0 d storage) from 60-wk-old breeder, while the lowest weight (32.1 g) was from for 15-d storage from 32-wk-old breeder hen.

Carcass and Organ Weight at Week 12

The influence of egg storage duration and the age of breeders on carcass traits in FUNAAB-α broiler chickens is presented in Table 5. Chickens of the 60-wk-old breeder hens had better weights in all carcass and organ characteristics except for liver, spleen, and abdominal fat. Chickens hatched from fresh eggs (0 d) had better carcass and organ weights than other storage days except for proventriculus. Weights of the carcass, drumstick, breast muscle, neck, thigh, shank, wings, and heart decreased with extended storage days. Chickens hatched from 7 d of egg storage length had similar proventriculus weight with 3, 11, and 15 d of storage but was higher than chickens from the unstored eggs (0 d).

Chickens from the 60 wk old breeder hens hatched from unstored eggs (0 d) had better carcass and organ weights than other storage days and also higher than chickens from the 32 wk old breeder hens across all storage duration except for BoF, abdominal fat, and proventriculus. With extended storage, gizzard, neck, and thigh weights of chickens from the 60-wk- old breeder hens decreased, but an inconsistent trend was observed in chickens of 32-wk breeder hen. Heart, proventriculus, abdominal fat, BoF, spleen, and liver weights were also not in a particular trend in both breeder hen across all storage days. Gizzard weights of chickens from the 32-wk-old breeder hens were reduced with protracted storage, but no trend was observed for 60-wk-old breeder chickens.

Discussion

This study evaluated the impact of egg storage duration and breeder's age on the growth performance and physiological responses of FUNAAB-α broiler chickens. The chickens from older breeders (60 wk) had better hatchling weights, FBWs, WG, FCR, and lower FI than chickens from younger breeders (32 wk). Higher hatchling (initial) weights from 60-wk-old breeders in this study can be attributed to heavier eggs being set during incubation. Additionally, the higher weight of the chicks from older breeders can be attributed to the higher yolk of the eggs (Machado et al., 2020). The yolk sac is a crucial nutrient

Table 3. Effect of egg storage duration and breeder age on serum biochemical indices in FUNAAB-α broiler chickens

	PROT	ALB	GLOB	AST	ALT	CHOL	TRIG	Na	K	Ca	T3	T4
Age (weeks)												
32	6.4^{a}	4.7^{a}	1.64	123.0^{a}	30.6	167.8^{b}	148.8^{b}	156.2^{a}	6.9^{a}	10.9^{a}	1.5	93.5
60	5.9^{b}	4.3^{b}	1.65	116.0^{b}	29.5	178.6^{a}	158.2^{a}	154.0^{b}	5.5^{b}	10.4^{b}	1.6	96.4
Storage (days)												
US	6.8^{a}	5.4^{a}	1.3^{c}	128.0^{a}	35.6^{a}	194.8^{a}	171.2^{a}	157.9^{a}	6.7^{a}	13.4^{a}	0.9^{c}	92.0
3DS	6.0^{ab}	4.6^{b}	1.5^{bc}	122.8^{ab}	32.5^{a}	177.7^{b}	136.2^{b}	153.9^{b}	5.8^{b}	10.3^{b}	1.8^{ab}	93.1
7DS	6.0^{ab}	4.2^{b}	1.9^{a}	113.3^{d}	28.3^{b}	182.8^{b}	147.0^{b}	154.5^{b}	5.6^{bc}	10.0^{b}	1.7^{ab}	96.4
11DS	6.1^{ab}	4.3^{b}	1.8^{ab}	114.8^{cd}	26.8^{b}	142.1^{d}	167.5^{a}	156.0^{ab}	5.1^{c}	9.1^{c}	2.1^{a}	95.2
15DS	5.8^{b}	4.0^{b}	1.8^{ab}	118.8^{bc}	27.0^{b}	168.7^{c}	145.5^{b}	155.1^{b}	5.8^{bc}	10.4^{b}	1.4^{b}	98.3
Age × storage												
32 × US	8.0^{a}	6.4^{a}	1.4^{bc}	151.0^{a}	46.0^{a}	208.6^{a}	166.1^{abc}	164.4^{a}	8.0^{a}	15.7^{a}	0.9^{cd}	83.4^{b}
32 × 3DS	6.2^{b}	4.7^{b}	1.5^{bc}	119.0^{bcd}	26.0^{c}	164.6^{cd}	129.5^{d}	151.7^{cd}	5.5^{b}	9.4^{c}	1.7^{abc}	92.0^{ab}
32 × 7DS	5.8^{b}	4.4^{b}	1.6^{abc}	111.5^{de}	27.5^{c}	178.0^{bc}	145.2^{cd}	154.9^{bcd}	5.8^{b}	10.1^{bc}	1.6^{abcd}	87.6^{ab}
32 × 11DS	6.3^{b}	4.3^{b}	2.0^{ab}	118.0^{bcd}	27.0^{c}	134.7^{f}	155.4^{abcd}	155.8^{bcd}	5.2^{b}	9.3^{c}	2.1^{a}	100.1^{ab}
32 × 15DS	5.6^{b}	3.9^{b}	1.7^{ab}	115.5^{cd}	26.5^{c}	153.3^{de}	147.6^{bcd}	154.1^{bcd}	6.0^{b}	10.1^{bc}	1.5^{abcd}	104.7^{a}
60 × US	5.6^{b}	4.5^{b}	1.1^{c}	105.0^{e}	25.3^{c}	180.9^{b}	176.2^{ab}	151.5^{d}	5.4^{b}	11.1^{b}	0.8^{d}	100.6^{ab}
60 × 3DS	5.9^{b}	4.5^{b}	1.4^{bc}	126.5^{b}	39.0^{b}	190.9^{b}	142.8^{cd}	156.0^{bc}	6.2^{b}	11.2^{b}	1.9^{ab}	94.2^{ab}
60 × 7DS	6.2^{b}	4.0^{b}	2.2^{a}	115.0^{cd}	29.0^{c}	187.7^{b}	148.8^{bcd}	154.1^{bcd}	5.3^{b}	9.9^{bc}	1.9^{ab}	105.3^{a}
60 × 11DS	5.9^{b}	4.3^{b}	1.6^{abc}	111.5^{de}	26.5^{c}	149.5^{ef}	179.6^{a}	156.3^{b}	5.1^{b}	9.0^{c}	2.1^{ab}	90.3^{ab}
60 × 15DS	6.1^{b}	4.1^{b}	2.0^{ab}	122.0^{bc}	27.5^{c}	183.9^{b}	143.4^{cd}	156.2^{b}	5.6^{b}	10.6^{bc}	1.3^{bcd}	92.0^{ab}
SEM	0.13	0.12	0.06	1.97	1.11	3.50	2.94	0.60	0.15	0.31	0.08	1.61
P-value												
Age (weeks)	0.019	0.004	0.907	0.001	0.198	0.001	0.020	0.026	0.001	0.012	0.522	0.279
Storage (days)	0.018	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.563
Age × storage	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.009

[a,b,c,d,e,f]means with different superscripts differ significantly within column ($P < 0.05$). PROT, total protein (nm/L); ALB, albumin (nm/L); GLOB, globulin (nm/L); AST, aspartate transaminase (nm/L); ALT, alanine transaminase (nm/L); T3, triiodothyronine (ng/dL); T4, thyroxine (ng/dL); CHOL, cholesterol (10^3/dL); TRIG, triglycerides (10^3/dL); Na, sodium (nm/L); Ca, calcium (nm/L); K, potassium (nm/L).

Table 4. Influence of breeder age and egg storage duration on relative organ weights at hatch in FUNAAB-α chicks

	Residual yolk weight (g)	YFBW (g)	% Liver	% Heart	% Intestine	% Gizzard
Age (weeks)						
32	3.2	32.3	2.8[b]	0.7	4.1	6.4
60	3.5	32.6	3.0[a]	0.7	4.3	6.3
Storage (days)						
US	2.9[b]	34.6[a]	2.8	0.6[b]	3.9[bc]	5.7[b]
3DS	3.2[b]	33.1[ab]	2.8	0.7[ab]	4.1[abc]	5.8[b]
7DS	4.4[a]	32.1[ab]	2.9	0.7[ab]	3.7[c]	6.9[a]
11DS	3.3[b]	31.9[ab]	2.9	0.7[ab]	4.7[a]	6.6[ab]
15DS	2.9[b]	30.4[b]	2.9	0.8[a]	4.5[ab]	6.8[ab]
Age × storage						
32 × US	2.9[bc]	34.4[ab]	2.8[ab]	0.6[c]	3.9[bcd]	5.7[b]
32 × 3DS	3.1[bc]	32.7[ab]	2.4[b]	0.6[c]	4.4[bc]	5.4[b]
32 × 7DS	4.4[a]	32.2[ab]	3.0[ab]	0.8[ab]	4.3[bc]	7.5[a]
32 × 11DS	3.3[bc]	32.6[ab]	2.8[ab]	0.8[abc]	3.6[cd]	6.5[ab]
32 × 15DS	2.6[c]	29.5[b]	2.8[ab]	0.7[abc]	4.4[bc]	7.1[ab]
60 × US	3.0[bc]	34.8[a]	2.8[ab]	0.7[c]	4.0[bcd]	5.8[ab]
60 × 3DS	3.5[ab]	33.5[ab]	3.1[a]	0.7[bc]	3.9[bcd]	6.2[ab]
60 × 7DS	4.3[a]	32.0[ab]	2.8[ab]	0.6[c]	3.1[d]	6.4[ab]
60 × 11DS	3.3[bc]	31.2[ab]	3.1[a]	0.7[bc]	5.8[a]	6.7[ab]
60 × 15DS	3.1[bc]	31.2[ab]	3.1[a]	0.9[a]	4.7[b]	6.4[ab]
SEM	0.1	0.4	0.1	0.0	0.1	0.1
P-value						
Age (weeks)	0.084	0.676	0.021	0.360	0.162	0.541
Storage (days)	0.001	0.007	0.658	00.001	0.005	0.007
Age × storage	0.383	0.664	0.020	0.001	0.001	0.124

[a,b,c,d]means of different superscripts differ within column ($P < 0.05$). YFBW, yolk-free body weight.

source during perinatal development. It was also observed from this study that the initial and FBWs, FI, WG, and FCR were lower in eggs stored beyond 7 d, which is in agreement with the report of Tona et al. (2003), who found a reduced growth rate in eggs stored after 14 d thereby leading to a reduced final weight of broiler at slaughter. Lower BWs of hatchlings due to egg storage can be linked to reduced quality of the chicks at hatch. The decrease in the FBWs with an increase in the storage duration in the present study suggests that the adverse impact of the storage duration was carried over to the market age. This is in agreement with Yang et al. (2021), who reported that storage time impaired the growth of chickens. The better BWs and FCR of chickens from 60-wk-old breeder hens stored for 0, 3, and 7 d compared to other storage days can be attributed to their enhanced growth rate up to slaughter age. This observation can be explained by the physiological parameters recorded in this study. This report, however, contradicts the findings of Tona et al. (2003), who reported enhanced weights only in broilers of younger breeders (35 wk) stored beyond 14 d. The authors further reported that considering storage length alone, stored eggs from younger hens produced slightly heavier birds despite their lower hatchling weights compared to the older breeders (45 wk). This may be explained by the shorter storage durations used, chicken strain, and different environmental conditions (Onbaşilar et al., 2007).

Hematological traits in avian species are used to estimate body conditions. They are considered genuine indicators of pathological and physiological statuses in animals (Esonu et al., 2001). Eosinophils and basophils do not confer antigenic specificity but rather play essential roles in the acute phase of infection (Charles Noruega, 2000). In this study, these cells were within the normal range for avian species and were not influenced by the breeder's age. The storage duration did not affect heterophil, monocyte, or eosinophil count except for basophils. The normal-range cell counts of heterophils, basophils, and eosinophils could be a result of contamination-free incubation. Higher levels of heterophils, basophils, and eosinophils could suggest unpleasant physiological conditions with indications of antigens in the circulatory system. This study agrees with the account of Morita et al. (2009), who reported no effect of breeder age and low cell counts of heterophil, basophils, and eosinophils while working on the influence of embryo age, sex, and breeder age on hematological traits in broilers.

The creation of antibodies and the building of barriers against diseases are two functions of lymphocytes. However, no effect of storage length on lymphocyte count was observed in this study, but the effect of breeder age and storage interaction was recorded. The main effect of age showed that higher lymphocyte count was recorded in chickens of 60 wk old breeders than those of the 32 wk-old breeders, suggesting higher immunological status in the older breeders acquired during their formative stage, which is essential against avian disease-causing agents when exposed to the external environment. RBCs are

Table 5. Influence of egg storage duration and breeder age on cut-parts and organs of FUNAAB-α broiler chickens

	CW %	BoF %	SPL %	LIV %	GIT %	BRST M %	DRST %	THIGH %	NECK %	HEAD %	SHANK %	GIZ %	ABD FAT %	WINGS %	HEART %	PROVT %
Age (weeks)																
32	58.5	0.0	0.1	1.2	3.4	8.7	5.4^{b}	6.1	2.7	1.6	1.1	2.3	0.5	4.6	0.3	0.2
60	59.1	0.0	0.1	1.1	3.5	9.1	5.8^{a}	6.3	2.7	1.6	1.1	2.3	0.4	4.7	0.3	0.3
Storage (days)																
US	68.1^{a}	0.8	3.8^{a}	1.5^{a}	4.2^{a}	10.7^{a}	6.3^{a}	6.7^{a}	2.8	1.8^{a}	1.4^{a}	2.8^{a}	0.4^{a}	5.4^{a}	0.3^{a}	0.2
3DS	64.8^{b}	0.5	1.0^{c}	1.0^{c}	3.5^{b}	9.4^{ab}	6.0^{ab}	6.6^{ab}	2.8	1.4^{b}	1.1^{b}	2.2^{b}	0.0^{b}	4.7^{b}	0.3^{a}	0.3
7DS	60.0^{c}	0.8	2.8^{ab}	1.3^{ab}	3.5^{b}	9.2^{ab}	5.5^{bc}	6.3^{ab}	2.7	1.7^{a}	1.0^{bc}	2.2^{b}	0.5^{a}	4.6^{b}	0.3^{a}	0.3
11DS	54.5^{d}	1.8	1.8^{bc}	1.0^{b}	3.1^{b}	8.2^{bc}	5.3^{c}	6.2^{b}	2.6	1.7^{a}	1.0^{bc}	2.2^{b}	0.4^{a}	4.5^{b}	0.3^{a}	0.3
15DS	46.8^{e}	0.6	1.8^{bc}	1.1^{b}	3.1^{b}	7.0^{c}	4.9^{c}	5.1^{c}	2.5	1.5^{b}	0.9^{c}	2.0^{b}	0.6^{a}	3.9^{c}	0.2^{b}	0.3
Age × storage																
32 × US	67.9^{a}	0.0^{b}	0.1	1.5^{a}	3.8^{ab}	10.0^{ab}	6.2^{a}	6.6^{a}	2.7	1.7^{abc}	1.4^{a}	2.8^{ab}	0.5^{ab}	5.3^{ab}	0.3^{ab}	0.2
32 × 3DS	64.9^{b}	0.0^{b}	0.1	1.1^{abc}	3.6^{b}	9.2^{abc}	5.9^{abc}	6.6^{a}	2.8	1.5^{cd}	1.1^{b}	2.1^{c}	0.0^{c}	4.6^{c}	0.3^{abc}	0.2
32 × 7DS	60.1^{c}	0.0^{b}	0.1	1.4^{abc}	3.6^{b}	8.7^{bc}	5.4^{abc}	6.3^{a}	2.7	1.7^{abc}	1.1^{b}	2.1^{bc}	0.4^{abc}	4.4^{cde}	0.3^{abc}	0.2
32 × 11DS	53.8^{d}	0.1^{ab}	0.1	0.8^{c}	3.0^{b}	8.3^{bc}	4.9^{c}	6.2^{a}	2.6	1.6^{bcd}	0.9^{b}	2.4^{abc}	0.6^{ab}	4.5^{cde}	0.3^{ab}	0.3
32 × 15DS	45.8^{e}	0.1^{ab}	0.1	1.3^{abc}	3.1^{b}	7.1^{c}	4.8^{c}	5.0^{b}	2.5	1.6^{abcd}	1.0^{b}	2.1^{bc}	0.8^{a}	4.0^{de}	0.1^{c}	0.3
60 × US	68.3^{a}	0.0^{b}	0.2	1.4^{ab}	4.7^{a}	11.4^{a}	6.4^{a}	6.8^{a}	2.8	1.8^{ab}	1.4^{a}	2.9^{a}	0.4^{bc}	5.4^{a}	0.3^{a}	0.2
60 × 3DS	64.6^{b}	0.1^{ab}	0.1	1.0^{abc}	3.4^{b}	9.6^{abc}	6.1^{ab}	6.6^{a}	2.7	1.3^{d}	1.1^{b}	2.3^{abc}	0.0^{c}	4.7^{bc}	0.3^{ab}	0.3
60 × 7DS	59.9^{c}	0.1^{ab}	0.1	1.3^{abc}	3.4^{b}	9.6^{abc}	5.7^{abc}	6.4^{a}	2.7	1.7^{abc}	1.1^{b}	2.3^{abc}	0.7^{ab}	4.6^{cd}	0.3^{ab}	0.4
60 × 11DS	55.3^{d}	0.1^{a}	0.1	1.2^{abc}	3.2^{b}	8.0^{bc}	5.7^{abc}	6.4^{a}	2.7	1.9^{a}	1.1^{b}	2.0^{c}	0.3^{bc}	4.7^{bc}	0.3^{abc}	0.3
60 × 15DS	47.6^{e}	0.0^{b}	0.1	0.9^{bc}	3.0^{b}	6.9^{c}	5.0^{bc}	5.2^{c}	2.4	1.4^{d}	1.0^{b}	1.9^{c}	0.4^{abc}	3.7^{e}	0.2^{bc}	0.3
SEM	1.2	0.0	0.0	0.0	0.1	0.3	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
P-value																
Age (weeks)	0.069	0.094	0.741	0.323	0.305	0.240	0.033	0.124	1.000	0.804	0.319	0.718	0.118	0.284	0.485	0.287
Storage (days)	0.001	0.006	0.004	0.001	0.001	0.001	0.001	0.001	0.182	0.001	0.001	0.001	0.001	0.001	0.001	0.114
Age × storage	0.001	0.003	0.203	0.002	0.001	0.001	0.002	0.001	0.554	0.001	0.001	0.001	0.001	0.001	0.004	0.162

^{a,b,c,d,e}means of different superscripts differ within column ($P < 0.05$). DW, dressed weight; BoF, Bursa of Fabricius, SPL, spleen; LIV, liver; GIT, gastrointestinal tract; BRST M, breast muscle; DRST, drumstick; GIZ, gizzard; ABD FAT, abdominal fat; PROVT, proventriculus; wks, weeks; d, days.

involved in the movement of carbon dioxide (CO_2), produced by tissue catabolism, from the periphery to the lungs, where it is exhaled, and they carry oxygen from the lungs to the tissues. RBC tests can help with anemic diagnosis and other problems affecting the RBCs (Bunn, 2011). The RBC recorded in this study values were within the normal range (2.2 to 4.0 million/μL), which suggested healthy birds. Higher than normal levels of RBC may be due to congenital heart disease, dehydration, and low blood oxygen levels (hypoxia), among other factors. Lower than normal values may be due to anemia, failure of the bone marrow, hemolysis, over-dehydration, and nutrient deficiencies. PCV, hemoglobin (Hb), and MCH are indices used in evaluating circulating avian erythrocytes and are germane in diagnosing anemia while they also serve as important indicators of the bone marrow capacity to generate red blood cells in animals (Chineke et al., 2006). In the present study, PCV, Hb, and MCH values were also within their normal range and increased with storage duration. These values were significantly higher in 32-wk-old breeder chickens than the 60-wk-old breeders. There was also evidence of breeder age and storage interaction on PCV, MCH, and Hb. Higher PCV readings can be attributed to either reduced circulating plasma volume or increased red blood cells (Chineke et al., 2006). Hemoglobin deficiencies decrease blood oxygen-carrying capacity, while higher than normal hemoglobin levels would have suggested above-normal levels of iron-containing protein in the red blood cells. Lower values of hemoglobin and PCV have been attributed to poor nutrition, particularly deficiency in protein (Iheukwumere et al., 2002; Adejumo, 2004). Most of the hematological parameters recorded in this study were within the normal range except for white blood cells (WBC). This could imply the normal physiological statuses of birds, irrespective of the age of the breeder and storage duration. The WBC plays a significant role in the synthesis of antibodies and recognition of foreign bodies. The elevated levels above the normal range of WBC in this study may suggest a defensive mechanism against the possible presence of infection in birds.

Serum biochemical parameters are used to provide valuable information about the physiological and biochemical status of an animal (Ajayi et al., 2022; Oni et al., 2024). Serum protein is synthesized in the liver and is responsible for the movement of insoluble substances present in the blood. It also aids in maintaining oncotic pressure. The age of breeder, storage length, and their interaction greatly influenced total protein levels in this study. Values recorded are higher than those reported by Barde et al. (2022) and Agboola et al. (2013). These high levels of total protein could suggest dehydration, kidney dysfunction, and liver impairment, which could cause abnormal accumulation of protein. Lower levels could be attributed to improper absorption or incomplete digestion of protein. Enzymes such as alanine transaminase (ALT) and aspartate transaminase (AST) albumin are essential in evaluating the adequate functions of the liver. This study observed a high concentration of AST, which can be attributed to a damaged liver or vitamin A deficiency. Extended storage and its interaction with the age of breeders also influenced AST and ALT concentration. No influence of breeder age was observed on ALT levels, unlike AST. Globulin conveys essential metals via the bloodstream to several other parts of the body and also assists in fighting various infections in the body. The age of breeder hens had no influence on globulin concentration in the present study. However, higher values of globulin above the normal range were observed in this study. With extended storage length, globulin levels increased in both breeder hens considered in this study. This elevated level is mainly common in birds with severe infections due to an abnormal rise in the secretion of antibodies. Extended duration and its interaction with breeder age had a significant influence on globulin concentration, which could have a severe effect on the health status of the birds. T3 and T4 play crucial roles in regulating metabolism, growth, and development in chickens. From this study, extended storage duration up to 15 d affected the levels of T3 levels but were all within the normal avian range (0.6 to 2.0 ng/dL), which suggests normal growth and metabolism of the chickens. Elevated levels of T3 and T4 could denote hyperthyroidism, which could be due to nutritional deficiencies, stress, excess iodine, and thyroid dysfunction.

In this study, higher hatchling weight, residual yolk sac, YFWB, liver and intestine percentage, lower heart percentage, and gizzard percentage were noticed in the chicks of the older breeder than the younger breeders. Sinclair et al. (1990) explained that the ability to naturally resist dehydration at hatch is why most hatchlings from older breeders are usually of high quality and larger compared to hatchlings from younger breeders. In the same line, the increment in the weight of the residual yolk sac in hatchlings from older breeders can be related to their higher yolk weight. The findings of the study by Sklan et al. (2003) showed an increase in residual yolk weight with the age of breeder. An increase in residual yolk weight has been ascribed to an increase in egg size (Nangsuay et al., 2011). Higher liver relative weights in the older breeders in this study align with those of Koppenol et al. (2015), who found a 0.08 increase in liver percentage at hatch with increased breeder age from 28 to 48 wk. The size of the gizzard may influence the digestibility of nutrients. Abioja et al. (2020) noted that the size of the gizzard became smaller with extended duration (16 d) in 32-wk-old breeder FUNAAB-α hen. This is contrary to the result in this study, where gizzard percentage increased as storage durations increased in both old (60 wk) and young (32 wk) breeders. However, the gizzard percentage was higher in hatchlings from the 32-wk-old than the 60-wk-old breeders. Extended storage duration resulted in a higher residual yolk sac and lower YFBW, making it hard for the embryo to internalize the yolk during incubation. The detrimental impact of storage on intestinal morphology, which results in birds from prolonged stored eggs being less able to absorb carbohydrates and proteins than those from short stored eggs at the end of the hatch window, maybe the cause of the decreased YFBM with prolonged storage (Yalcin et al., 2016). Nasri et al. (2020) also reported that extended storage duration yielded higher residual yolk sacs, lowered yolk efficiency, and YFBW in Arbor Acres. The effect of egg storage and breeder age interaction on hatchling weight in the present study is in contrast to the report of Nasri et al. (2020). These authors found that the weights of embryos stored for 18 d increased with parental age.

In the present study, the carcass weight of broilers from the 60-wk-old breeder hens was bigger than those from the 32-wk-old breeder hens. The differences in the relative weights recorded in this study suggest that the impacts of breeder age and storage duration did not disappear in the chickens at this stage. Our observation is in line with the report of Eroglu et al. (2021), who reported higher slaughter weights in geese of older breeders compared to the young breeders. This study further identified higher head, breast muscle, head, drumstick, spleen, liver, heart, neck, abdominal fat, thigh, gizzard, GIT, proventriculus, shank, and wings weights with chickens from the 60-wk-old breeder. Generally, the carcass parts and organs of groups with higher BWs were heavier. This influence is also directly related to breeder age, as chickens from the older breeder (60 wk) had higher weights than those obtained from the young breeder (32 wk). The present study further indicates that chickens from unstored eggs (0 d) had higher carcass and organ weights except for proventriculus compared to other storage durations. This agrees with Alsobayel and AL-Miman (2010), who observed higher abdominal fat, carcass, and liver weights in birds hatched from 1-d stored eggs than the eggs stored for 14 and 7 d.

To conclude, FUNAAB-α broiler breeders' age and storage significantly affected post-hatch growth and physiological indices. Storage negatively impacted the growth performance indices of chickens from eggs storage longer than 7 d, and a prominent effect was recorded in chickens from younger breeder hens (32 wk). Breeder age and storage duration effect was observed on considerable hematological and serum biochemical characteristics but were within the normal range of avian species. However, the highest PCV, WBC, RBC, total protein serum, serum globulin, and albumin found in younger breeder hens suggest healthier chickens. The implication of this study is that it is not recommended to store the hatching eggs of FUNAAB-α broiler breeders beyond 7 d before the commencement of incubation.

Conflict of interest statement

The authors declare no conflict of interest.

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