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Effects of paper crates, plastic bowls and duration of storage on egg quality characteristics of laying chicken

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Target Audience: *Poultry Scientists, Farmers, Extension Workers, Agricultural Researchers.*

Abstract

This study aimed at evaluating the effect of duration and medium of storage on the external and internal qualities of chicken eggs. A total of 210 fresh eggs from the Plymouth Rock layer breed of chicken were purchased from a commercial farm. All eggs for the study were collected the same day and carefully transported to the laboratory. Fifteen eggs each were randomly allotted to each treatment (0 week: fresh eggs; 2 weeks; 4 weeks and 6 weeks respectively) in two storage media (paper crate and plastic bowl). Eggs in each storage medium were replicated three times with five pieces in each replicate. On each sampling day, eggs were weighed, the length and breadth of the eggs were measured, the eggshell thickness was determined, the albumen heights were measured and yolk colour was determined. These measured parameters were conducted at intervals of two weeks for a period of six weeks. All data obtained were subjected to statistical analysis using t-test and analysis of variance (ANOVA) to compare the effects of storage media and duration of storage on parameters measured respectively. As storage time increased, egg weight, albumen height and Haugh unit significantly ($p<0.05$) decreased (after 2 weeks of storage) while egg length, egg breadth, shell thickness, and egg shape index (ESI) were not significantly affected ($P<0.05$) in both media. From the results, it is concluded that eggs from laying chickens could be stored for 14 days before deterioration could set in and both media of storage could be used interchangeably.

Keywords: Paper crate, plastic bowl, duration, medium of storage.

Description of Problem

Poultry egg is one of the most affordable and acceptable animal products. Eggs possess two characteristics that make them valuable as foodstuff, namely, they are highly nutritious, and serve important roles in many food products because of their functional properties (1). Thus, they are excellent means by which the animal protein requirement of the populace can be met. Also, eggs provide 18 vitamins and minerals, the composition of which can be affected by several factors such as chicken diet, strain as well as environmental factors. (2) noted that the quality of an egg is determined by various standards that are imposed on the exterior (quality of the egg shell) and interior (quality of the albumen and yolk) components of the egg. Nevertheless, although different compositions have been reported by several authors on average, the macronutrient content of eggs include low carbohydrates, and about 12g per 100g of protein and lipids (3). The superior amino acids profile that eggs contain aid in the prevention of lean muscle mass, which is a primary promoter of bone health. Eggs are rich in the antioxidants: Selenium, Lutein,

and Zeaxanthin, therefore, eating egg can reduced inflammation in the body and promote overall health, for instance, Selenium is a crucial nutrient in the body's antioxidant defenses and it aids in the production of thyroid hormones and reproduction health.

Although eggs are known to possess excellent keeping quality, like all food, they have limited shelf life (4). Deterioration of eggs starts soon after lay. Thus egg handling and storage practices have a significant impact on the quality of eggs reaching consumers. Albumen and yolk quality are not only important indicator for the egg freshness but are also important for the baking industry because of egg albumen and egg yolk that are involved (5). (6) noted that both albumen and yolk proteins of whole eggs contribute to the formation and stabilization of the aerated structure in bakery products.

In most part of Nigeria, eggs are usually stored at ambient temperature until they are sold or consumed. To maintain the consumer's acceptability, it is critical that proper storage is done, various factors such as egg storage period and conditions, strain and age of chicken are major important factors influencing egg quality (7). There is however, dearth information in respect to duration or period and medium of storage of egg from the Nigerian chicken.

Currently, poultry production has become intensive in Nigeria and has become a dependable source of income for many farmers with increase in poultry production and harvest of poultry productions; we are faced with the pressing need to preserve poultry products. In this case, post-harvest loss due to spoilage and wastage should be reduced to its barest minimum.

Several studies have been done on effect of storage period and/or methods on egg quality characteristics of different breeds/strains of poultry birds (8; 9; 7). Duration is the measurement of length of time that something is kept. It is also a measure of time between two ends of a specific period. Considering the effect of duration of storage of an egg has to do with the question of how long can egg stay before it goes bad, that is, the shelf life of an egg. When eggs are properly handled and stored it rarely spoil, however if they are kept for too long, they are likely to dry up and loose quality.

The storage of egg, it is the method used in preserving egg and such medium includes: refrigerator at 40 °F or below or may be stored in a refrigerated case, open carton, in plastic or paper crates at room temperature. Most Farmers use paper crates to store their eggs after collection from the farm. It has also been noticed that most market women use plastic bowls when paper crates are not sufficient to carry and store eggs. Currently, there is no information on the effects this plastic bowl medium on eggs quality parameters. The most influential egg quality parameters are: weight, shell thickness and porosity, shape index: described as maximum breath to length ratio. Egg characteristics also include egg weight, specific gravity, yolk weight, albumen weight, albumen height, and egg shell thickness. Therefore, the objectives of this study were to evaluate the effects of duration and media of storage in terms of paper crates and plastic bowls on the internal and external quality characteristics of eggs of laying chicken.

Materials and Methods

Experimental site:

This research was carried out in the Agriculture Laboratory, Wesley University Ondo, Nigeria. The study was carried out under an ambient temperature of 27 with coordinates 5.45 and 7.5 latitudes and 4.20

and 6.0 longitude and area is about 15,500 square kilometers of the ecological zone of Nigeria with a humid dry climate. The annual mean rainfall ranges between 288 m with a daily temperature of 26-36^{o}C and relative humidity of 85% as reported by Google Earth (2018). This study commenced during the wet season in the month of July. A total of 210 fresh eggs from a Plymouth rock layer breed chicken were purchased from Igbado Agro-allied farm along Ondo-Ore road, Ondo State. All eggs for the study were collected the same day and carefully transported to the experimental site (Agriculture laboratory, Wesley University, Ondo). Eggs collected the same day were weighed immediately after arrival. On each sampling day, eggs were weighed with a digital scale, the length and breadth of the eggs were measured using the Vernier calliper, and eggshell thickness was measured using the Micro screw gauge. The eggs were broken on a white breakable flat plate surface and the yolk was carefully separated from the albumen. The albumen height was measured using the Spherometer and thereafter yolk colour was determined through a visual method using the Roach Yolk colour fan. These measured parameters were conducted every two weeks for the period of six weeks (a month and two weeks).

Experimental Design: The experimental design was 2 by 4 Factorial designs. The study used four durations of storage and two media of storage. Fifteen eggs were randomly allotted to each treatment (0 week: fresh egg; 2 weeks; 4 weeks and 6 weeks respectively) in two storage media (paper crate and plastic bowl). Eggs in the paper crates and plastic bowls were replicated three times with five pieces in each replicate. Thirty pieces of eggs were used on each sampling day. Two factors were considered**:** Duration of storage and Storage medium, where durations of storage were 0, 2, 4, and 6 weeks and storage media were paper crates and plastic bowls.

Parameters Determined:

Egg weight: Digital Scale was used to determine the weight of each egg. The weight is measured in mg.

Egg length and breadth: The egg length and breadth were measured by the Vernier Caliper. Egg length and breadth were measured in mm.

Albumen height: Albumen height was measured by the use of a Spherometer. The Spherometer is an instrument used for measuring the radius of curvation of a spherical surface. It was measured in millimetres.

Shell thickness: Shell thickness was determined by the use of a Microscrew gauge: Shell thickness was measured in millimetres (mm). The eggshell thickness was measured by placing a part of the eggshell between the spindle and the anvil of the microscrew gauge and then moving it by turning the ratchet knob until the eggshell touched the spindle and the anvil.

Yolk Colour: The egg colour fan is an instrument/equipment that is calibrated from 1 to 15 scales colour index that aids in distinguishing the yolk colour density with each calibrated number representing the quality of the yolk colour.

Egg shape index: Egg shape index is defined as the ratio of width to length of the egg, and it is an important criterion in determining egg quality. It was measured as Egg weight/Egg height x 100(Egg W/Egg H ×100=ESI).

Table 1: Mean values for parameters measured in paper crates as affected by duration of storage

PARAMETER	DURATION	N	MEAN + S.D	SEM	MIN	MAX
EGG WEIGHT(g)	0 Week	15	66.16± 4.51[a]	1.16	58.21	72.89
	2 Weeks	15	62.96 ± 4.34[a]	1.12	56.48	69.48
	4 Weeks	15	57.65± 3.95[b]	1.02	49.48	64.65
	6 Weeks	15	58.86 ± 4.74[b]	1.23	48.53	66.15
EGG LENGTH(mm)	0 Week	15	5.72 ± 0.21[a]	0.06	5.45	6.17
	2 Weeks	15	5.77± 0.29[a]	0.08	5.16	6.51
	4 Weeks	15	5.61 ± 0.25[a]	0.06	5.24	6.10
	6 Weeks	15	5.75± 0.19[a]	0.05	5.41	6.10
EGG BREADTH(mm)	0 Week	15	4.45 ± 0.19[a]	0.05	4.03	4.71
	2 Weeks	15	4.44± 0.09[a]	0.03	4.24	4.57
	4 Weeks	15	4.36 ± 0.12[a]	0.03	4.15	4.58
	6 Weeks	15	4.41± 0.14[a]	0.04	4.20	4.68
EGG SHELL THICKNESS(mm)	0 Week	15	0.43 ± 0.09[a]	0.02	0.16	0.49
	2 Weeks	15	0.27± 0.05[a]	001	0.43	0.49
	4 Weeks	15	0.46± 0.01[a]	0.00	0.43	0.48
	6 Weeks	15	0.47± 0.02[a]	0.00	0.42	0.49
ALBUMEN HEIGHT	0 Week	15	0.36 ± 0.05[a]	0.01	0.32	0.47
	2 Weeks	15	0.27± 0.05[b]	0.01	0.19	0.38
	4 Weeks	15	0.21± 0.04[c]	0.01	0.14	0.30
	6 Weeks	15	0.20± 0.07[c]	0.02	0.13	0.34
YOLK COLOUR	0 Week	15	11.47± 1.19[a]	0.31	10.00	13.00
	2 Weeks	15	10.00± 1.13[b]	0.29	8.00	12.00
	4 Weeks	15	10.53± 1.44[ab]	0.37	9.00	13.00
	6 Weeks	15	10.60 ± 1.12[ab]	0.29	9.00	13.00
EGG SHAPE INDEX	0 Week	15	0.78 ± 0.03[a]	0.00	0.73	0.83
	2 Weeks	15	0.77± 0.04[a]	0.01	0.69	0.86
	4 Weeks	15	0.78± 0.03[a]	0.00	0.70	0.81
	6 Weeks	15	0.76 ± 0.03[a]	0.00	0.72	0.82
HAUGH UNIT(HU)	0 Week	15	82.42 ± 3.08[a]	0.79	178.80	186.50
	2 Weeks	15	79.99 ± 2.99[b]	0.77	175.30	184.30
	4 Weeks	15	76.09 ± 3.06[c]	0.79	169.60	184.20
	6 Weeks	15	77.20 ± 3.90[c]	1.00	168.70	182.40

Means with different superscripts are significantly difference at $P<0.05$

Table 2: Mean values for all parameters in bowl as affected by duration of storage

PARAMETER	DURATION	N	MEAN + S.D	SEM	MIN	MAX
EGG WEIGHT(g)	0 Week	15	62.48 ±4.73[a]	1.22	57.68	73.74
	2 Weeks	15	56.82 ± 4.36[b]	1.12	56.31	71.69
	4 Weeks	15	57.76± 3.52[b]	0.91	50.57	62.83
	6 Weeks	15	59.92 ± 4.11[a]	1.06	51.05	65.96
EGG LENGTH(mm)	0 Week	15	5.60 ± 0.22[a]	0.06	5.25	6.21
	2 Weeks	15	5.76± 0.18[a]	0.05	5.57	6.28
	4 Weeks	15	5.61± 0.26[a]	0.07	5.13	6.10
	6 Weeks	15	5.58± 0.16[a]	0.04	5.41	5.94
EGG BREADTH(mm)	0 Week	15	4.34 ± 0.17[a]	0.04	4.14	4.73
	2 Weeks	15	4.43± 0.13[a]	0.03	4.21	4.69
	4 Weeks	15	4.30 ± 0.10[a]	0.03	4.17	4.58
	6 Weeks	15	4.41± 0.15[a]	0.02	4.23	4.94
EGG SHELL THICKNESS(mm)	0 Week	15	0.43 ± 0.09[a]	0.02	0.20	0.49
	2 Weeks	15	0.23 ± 0.05[b]	0.00	0.37	0.49
	4 Weeks	15	0.46± 0.01[a]	0.00	0.44	0.48
	6 Weeks	15	0.47± 0.02[a]	0.00	0.40	0.47
ALBUMEN HEIGHT	0 Week	15	0.36 ± 0.05[a]	0.01	0.26	0.46
	2 Weeks	15	0.27± 0.09[b]	0.02	0.16	0.54
	4 Weeks	15	0.19± 0.04[c]	0.01	0.14	0.29
	6 Weeks	15	0.19± 0.05[c]	0.01	0.12	0.27
YOLK COLOUR	0 Week	15	11.20± 1.52[a]	0.39	8.00	14.00
	2 Weeks	15	10.06± 1.03[b]	0.27	8.00	12.00
	4 Weeks	15	10.66± 1.05[ab]	0.27	9.00	13.00
	6 Weeks	15	11.13±1.19[a]	0.31	10.00	13.00
EGG SHAPE INDEX(mm)	0 Week	15	0.78 ±0.04[a]	0.00	0.74	0.88
	2 Weeks	15	0.77± 0.04[a]	0.00	0.69	0.85
	4 Weeks	15	0.77± 0.04[a]	0.00	0.71	0.82
	6 Weeks	15	0.79±0.03[a]	0.00	0.75	0.87
HAUGH UNIT(HU)	0 Week	15	79.6 ± 3.02[a]	0.84	175.40	186.80
	2 Weeks	15	79.70 ± 3.02[b]	0.78	175.20	185.90
	4 Weeks	15	75.50 ± 2.69[c]	0.69	170.50	179.90
	6 Weeks	15	76.17 ± 3.06[c]	0.78	170.90	182.10

Means with different superscripts are significantly difference at P<0.05

Haugh unit (HU): Haugh unit was determined by equation (HU= 100*Log (h+7.57)-(1.7 * W 0.37). The Haugh unit is a measure of egg protein quality based on the height of its egg white (albumen) and egg weight.

Table 3: Effects of medium of storage on parameters measured

PARAMETER	MEDIUM	N	MEAN + S.D	SEM	Df	F-test	T-test	Sig.
EGG WEIGHT(g)	CRATE	60	61.41± 5.47[a]	0.71	118	1.317	1.575	0.118 NS
	BOWL	60	59.92± 4.89[a]	0.63	118	1.317	1.575	0.118 NS
EGG LENGTH(mm)	CRATE	60	5.71 ± 0.24[a]	0.31	118	0.931	1.799	0.075 NS
	BOWL	60	5.64 ± 0.22[a]	0.31	118	0.931	1.799	0.075 NS
EGG BREADTH(mm)	CRATE	60	4.41± 0.14[a]	0.02	118	0.202	1.544	0.125 NS
	BOWL	60	4.38 ± 0.15[a]	0.02	118	0.202	1.544	0.125 NS
EGG SHELL THICKNESS(mm)	CRATE	60	0.45 ± 0.05[a]	0.01	118	0.104	0.235	0.814 NS
	BOWL	60	0.45± 0.05[a]	0.01	118	0.104	0.235	0.814 NS
ALBUMEN HEIGHT	CRATE	60	0.26± 0.08[a]	0.01	118	0.363	0.016	0.988 NS
	BOWL	60	0.26 ± 0.09[a]	0.01	118	0.363	0.016	0.988 NS
YOLK COLOUR	CRATE	60	10.70± 1.13[a]	0.17	118	0.527	0.284	0.777 NS
	BOWL	60	10.77± 1.27[a]	0.16	118	0.527	0.284	0.777 NS
EGG SHAPE INDEX	CRATE	60	0.77± 0.03[a]	0.00	118	0.137	1.124	0.263 NS
	BOWL	60	0.78± 0.04[a]	0.00	118	0.137	1.124	0.263 NS
HAUGH UNIT(HU)	CRATE	60	178.92± 4.05[a]	0.52	118	1.520	1.695	0.093 NS
	BOWL	60	177.75 ± 3.52[a]	0.46	118	1.520	1.695	0.093 NS

Means are significantly the same at P>0.05.

Statistical analysis

All data obtained were subjected to statistical analysis using a t-test to compare the effect of the medium of storage (paper crate and plastic bowl) and analysis of variance (ANOVA) was done to compare the effect of duration of storage on parameters measured. Significant means were separated using the Duncan Multiple Range test at $p<0.05$.

Results

Tables 1 and 2 show the mean values for all parameters measured in crate and bowl as affected by the duration of storage; the mean values of egg weight (EW), egg length (EL), egg breadth (EB), shell thickness (ESH), albumen height (ALBH), yolk colour (YLKC), eggshell index (ESI), and Haugh unit (HU). There were downward reductions in the mean values of EW from the fourth week as the duration increased in paper crates. The mean values for egg weight stored in the plastic bowl also took the same trend as affected by the duration of storage. Mean values for EL at 0 weeks for the crate to 6 weeks were not significantly different. Mean values for egg length (EL) stored in the bowl also took the same trend as affected by the duration of storage. Mean values for EB at 0 weeks to 6 weeks in paper crates were not statistically significant. The mean values for egg breadth (EB) stored in the plastic bowls also took the same trend as

affected by the duration of storage. Mean values for EST at 0 weeks to 6 weeks in paper crates were not also statistically significant. The mean values for EST stored in the bowl also took the same trend as affected by the duration of storage. Mean values for ALBH at 0 weeks in paper crates differed significantly from other durations of storage. Weeks 4 and 6 were not statistically significant for ALBH in paper crates. The mean values for ALBH weight stored in plastic bowls also took the same trend as affected by the duration of storage. The mean values for YLKC at 0 weeks to 6 weeks in paper crates were also significant. The mean values for YLKC stored in the bowl also took the same trend as affected by the duration of storage. Mean values for ESI at 0 weeks to 6 weeks in paper crates were not statistically significant. The mean values for ESI stored in the bowl also took the same trend as affected by the duration of storage. While HU at 0 weeks to 6 weeks in paper crates differed significantly. Mean values for HU stored in the bowl also took the same trend as affected by the duration of storage. Table 3 shows the effect of the medium of storage on parameters measured in both paper crates and plastic bowls as affected by the period of storage. Results of the effect of medium of storage on all egg parameters measured revealed that medium of storage had no differential significant effects on both internal and external qualities of eggs ($p<0.05$).

Discussion

There have been reports of decreased egg weight as storage time increased (9). According to (9) and (10) reported that the rate of loss tends to vary depending on the storage time. Egg weight was adversely affected by the duration of storage which occurred in both paper crates and plastic bowls. Egg length and breadth were not significantly affected in both media of storage. The duration of storage did not affect the dimensions of the eggs. The external qualities were not affected by the medium of storage (15; 11; 19). Albumen and yolk colour were both affected in both media of storage with increasing storage time. Similarly, the albumen height, yolk colour and Haugh unit (HU) significantly ($P<0.05$) decreased with increasing storage time. The same effects were found in both media. The medium effect was not felt since both paper crates and plastic bowls offered the same durability and preservation. Internal qualities were greatly affected by the duration of storage in both paper crates and plastic bowls (17). The findings agreed with the reports of (12) and (13). The Haugh unit is an important trait in egg grading and is highly influenced by the albumen height. The content and nature of the ovomucin appeared to be primarily responsible for determining albumen height (14; 15). Haugh unit was greatly affected by the duration of storage while the medium showed no differential effect (16; 18). It was observed that the egg qualities remained intact till 14 days (2 weeks) of preservation in both paper crates and plastic bowls. Deterioration set in after 14 days of storage which had adverse effects on the internal qualities of eggs (Albumen, Yolk colour and Haugh Unit) in both media of storage. It can be deduced that plastic bowls can adequately replace the paper crates in case the paper crates are not sufficient on the farm. Farmers are advised not to store their eggs beyond two weeks in any medium of preservation. Egg qualities cannot be conserved beyond 14 days and a maximum of 28 days of storage.

Conclusions and Application

1. Egg weight at 0 week and 2 weeks were intact but weight loss

significantly increased at four weeks of storage.

2. Albumen height, yolk colour and Haugh unit (HU) significantly decreased at four weeks with increasing storage time.
3. There were no significant differences in all parameters measured (egg weight, egg length, egg breadth, eggshell thickness, albumen height, yolk colour, and Haugh unit) in paper crates as compared to plastic bowls.
4. It is recommended that eggs should be stored for up to two weeks without affecting adversely the internal and external quality characteristics measured. Also, plastic bowls could be used to replace paper crates when there is a shortage of paper crates on the farm.

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