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Research Paper

Effect of Colour, Source and Storage on Quality of Table Eggs in Port Harcourt Metropolis, Rivers State, Nigeria

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ABSTRACT:- *This study was carried out to investigate the quality and the optimum length of storage of Table eggs in Port Harcourt Metropolis Rivers State, Nigeria. The design of the study was the 3 x 3 factorial experiments in a Randomized Complete Block Design (RCBD). Four hundred and eighty (480) brown and white coloured eggs collected from the farm, market and shops were studied with regards to internal and external qualities under room temperature and market environment for four week. The result showed that there were significant differences ($p < 0.05$) based on the colour and source on egg length, egg shape index and all the internal characteristics examined. The length of storage significantly ($p < 0.05$) affected the egg weight, egg shape index and all the internal characteristics. The eggs analyzed at 4 weeks old gave very poor quality (Haugh Unit, HU = 22.73) compared with those analyzed the day they were laid or on arrival in the market (HU = 54.88). The result of the interactive effect of colour and source did not affect the external characteristics but significantly ($p < 0.05$) affected the internal characteristics, such that the white eggs from the farm and market had poor quality (HU = 39.30 and 39.07) compared with the brown egg from the two sources (HU = 57.38 and 51.23). It was therefore concluded that eggs should be consumed within the first three weeks of lay in the warm humid tropics when stored at room temperature or bought from the market since significant deterioration was evident in the 4^{th} week of storage.*

Keywords:- *Brown egg, haugh unit, humid, quality, source, storage, white egg*

I. INTRODUCTION

The chicken egg is a source of reproduction to the bird and serves as animal protein to man [1]. Animal protein is important in human diet for growth, maintenance and repair of body tissues, maintenance of the water balance of the body and the formation of hormones and enzymes. Thus the avian egg is considered to be a store house of nutrients such as protein, lipids, enzymes and various biological active substances including growth promoting factors as well as defense factors against bacterial and viral invasion [2]. Specifically, egg is an excellent, easily digestible food and a rich source of protein of high biological value. It contains significant amount of good lipids, vitamins and nutrients that are indispensible to good growth and healthy development of the human body.

Egg quality on the other hand is composed of those characteristics of an egg that affects its acceptability by the consumers [3]. Thus, attention should be paid to the problems of preservation and marketing to maintain quality [4,5]. The external qualities such as cleanliness, freshness, egg weight, shell weight, and the internal qualities such as yolk index, haugh unit and chemical composition are important in the egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases [6]. Although the Haugh unit (HU) is a standard for determination of the interior quality of egg, the rate of quality loss as measured by HU is a non-linear function [7]. Egg usually deteriorates in the internal quality with time depending on the shell and the internal content [5,8] and on the storage environment such as elevated temperature [9]. Consequently, [10] reported that high quality eggs have HU which ranged from 57.95-61.86 while inferior quality eggs had values less than 40. To preserve egg for a longer period, methods like low temperature and modified atmosphere packaging (refrigeration) had been recommended [11].

There is a dearth of information on the appropriate length of storage of eggs and the effect of colour on its quality in the warm humid part of Nigeria. It was therefore necessary to determine the optimum duration of eggs and the time when egg sellers are expected to withdraw eggs from their counters to avoid selling deteriorated eggs to customers, as it is the practice in developed countries. This study was therefore aimed at

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assessing the effect of colour on the internal and external qualities of eggs collected from farms, shops and markets and the optimum length of storage of the product in Port Harcourt Metropolis.

II. MATERIALS AND METHODS

2.1 Experimental Location: The research was carried out in Port- Harcourt Metropolis. Port Harcourt is the capital of Rivers State and a Port Town in Southern Nigeria. The town lies between longitude $6^{o}55N$ to $7^{o}10E$ and latitude $4^{o}35N$ to $4^{o}54N$ of Greenwich meridian, covering a total area of 804 km^2 [12]. Climatically, the city is situated within the sub-equatorial region with the tropical monsoon climate characterized by high temperature, low pressure and high relative humidity all the year round. The mean annual temperature, rainfall and relative humidity are $30^{0}C$, 2,300mm and 90% respectively with high population of 3.7 million [13]. The metropolis is made of Port- Harcourt City and some part of Obio/Akpor Local Government Area.

2.2 Research design, experimental procedure and data collection: The design of the experiment was the 3x3 Factorial Experiment of the Randomized Complete Block Design (RCBD). The experiment was conducted during the rainy season (July- August).

The duration of the experiment was 4 weeks. Four hundred and eighty (480) eggs were collected for the study. Two hundred and forty (240) eggs from a reputable medium sized farms within the Metropolis (where birds were fed with a commercial layers diet) and 240 eggs from the four major markets and shops in the metropolis. The 240 eggs from the farm comprised of 120 brown and 120 white eggs. The 240 eggs from the market and shops also comprised of 120 white and 120 brown eggs. These were collected from the 4 main markets, namely Mile1, Mile 3 market, Creek Road market and Oil mill market and 10 shops which were randomly sampled in the Metropolis. The eggs bought from the market and shops were intentionally left with the seller and collected on the day when they were analyzed while those from the farm were kept at room temperature pending the time when they were analyzed weekly. Eggs were therefore analyzed on the day when they were laid (those from the farm) or on the day they arrived the market or shop (for those from the markets and shops) while subsequent records were taken weekly (using 96 eggs weekly from the farm and market).

2.3 External qualities: Individual egg weight was collected with the aid of a electronic sensitive weighing scale and recorded in grams. The egg length was measured with a venire caliper. It was taken as the longitudinal distance between the narrow and broad ends of the egg. The egg width on the other hand was taken as the diameter of the widest cross-sectional region with a Venier caliper. The shell was properly cleaned and weighed with a sensitive electronic weighing scale, while the shell thickness was measured with micrometer screw gauge.

2.4 Internal qualities: The eggs were carefully broken at the middle to keep the yolk intact and emptied into a petri dish. Individual yolk was separated from the albumen and weighed. Yolk height was recorded and diameter was taken as the maximum cross sectional diameter with a pair of vernier calipers. Albumen heights were also obtained by measuring the widest expanse of the thick albumen, between the yolk edge and the external edge of the thick albumen. Albumen weight was obtained using a sensitive weighing balance after removing the intact yolk. The albumen and yolk P^{H} were determined using the universal P^{H} indicator. The haugh unit was calculated using a mathematical expression from the values obtained from egg weight and albumin height with the formula:

Haugh unit (HU) = $100kg\ (H+7.5 - 7w^{0.37})$

Where H= Albumin height in cm W= egg weight in grams

The egg shape index was obtained using the formula: $\frac{\text{Width of egg}}{\text{Length of egg}} \times 100$

The yolk ratio was obtained using the mathematical expression:

$$\frac{\text{Yolk weight}}{\text{Egg weight}} \times 100$$

2.5 Data analysis: Data collected from the quality assessment were subjected to statistical analysis using SAS software [14] while significant difference between the means were determined using Duncan Multiple Range Test [15].

III. RESULT AND DISCUSSION

3.1 Effect of colour and source on the external characteristics of egg

The result in Table 1 showed that some of the external characteristics such as egg weight, egg width, shell weight and shell thickness were not significantly ($P>0.05$) affected by colour (brown and white) and source (farm and market). This could be as a result of environmental factors such as the relative humidity and

temperature which was stable at about 2300mm and 25^{o}C – 30^{o}C during the study. This result was at variance with [16] who revealed that egg weight, shell thickness and shell weight were higher in brown egg than in white egg. However, it agreed with the findings of [17] who reported that there were no significant differences among the external qualities based on shell colour of eggs. The significant differences in egg length and egg shape index could be attributed to the different sources (strains of birds) from where the egg sellers obtained the eggs. Thus, supporting the findings of [18] who reported that there were significant differences among external qualities including egg length when two strains of bird were studied.

3.2 Effect of length of storage on the external characteristics of egg

The result in Table 2 indicated that the egg weight was significantly (P<0.05) affected by storage in the 4th week. The loss in weight of the eggs noticed in the 4th weeks of storage could be due to the loss of water by evaporation as a result of the longer duration. This finding was sharply different from the findings of [19] who recorded fast deterioration of eggs after 2 weeks when stored at room temperature of 37^{o}C and [17] who reported that egg stored for fourteen days in Bauchi State in northern Nigeria (hot environment), lost more weight compared to eggs stored for one day and seven days respectively. Thus, confirming the report by [19] who stated that losses in egg weight were positively related to the storage period and the environment.

The result which further revealed that there were no significant (P>0.05) differences among other external qualities such as egg length, egg width, shell weight and shell thickness was in contrast with the finding of [18] who reported that there were significant differences in egg length, egg width, shell weight and shell thickness when the eggs of two strains of birds were examined. The egg shape index which were significantly different but without any regular pattern did not tally with the report by [17] who stated that egg shape index was not affected by storage duration.

3.3 Interactive effect of colour and source on external characteristics of egg

The result from the interactive effect of colour and source on the external characteristics in Table 3 did not give any significant effect on the parameters measured. This could be as result of the similarity in the weight of the eggs that were sampled for the study.

3.4 Effect of colour and source on the internal characteristics of egg

Table 4 indicated that there were significant (P<0.05) differences among all the internal qualities measured (yolk weight, yolk height, yolk ratio, yolk pH, albumen weight, albumen height, albumen pH and haugh unit) based on shell colour and the source of the egg. This was as a result of the easily observable changes such as the thinning of the thick albumen, the flattening of the yolk and the changes related to ageing of the albumen and the yolk as stated by [3].

The quality of white eggs which were significantly lower compared to the brown eggs was in contrast to the finding by [16] who reported that there was no difference between the brown and white egg with respect to internal quality.

3.5 Effect of length of storage on the internal characteristics of egg.

The result of the effect of length of storage on the internal characteristics of egg (Table 5) showed that there were significant (P<0.05) difference among the internal characteristic such as yolk weight, yolk height, yolk P^{H}, albumen weight, albumen height, albumen p^{H}, haugh unit.

The higher HU in weeks 1-3 showed that the eggs had good quality since [10] stated that the HU of high quality egg ranged from 57.95-61.86 while inferior quality eggs had values less than 40. The HU of the eggs stored for 4 weeks (22.73) which was below the recommended HU of 40 and significantly lower than those stored for 1 to 3 weeks, confirmed that the eggs were not good for consumption. The decline in the egg quality in the 4th week was due to the storage condition, mainly increased duration in this case. This was in line with [20] who stated that the parameters for measuring the quality traits of all eggs were at maximum when the eggs were freshly laid and decreased with increased storage time. This agreed with the principle that the thick albumen progressively liquefies and thins with time, thus transforming itself into thin albumen and fattening of the yolk caused by weakening of the vitelline membrane as the egg aged [21].

The increase in yolk weight compared with the value on arrival at the market or the day of lay tallied with the findings of [22] who found that yolk weight increased with storage length due to movement of water from the albumen to yolk as a result of the osmotic pressure difference, causing the yolk to change from spherical shape to flabby mass.

The albumen pH of the eggs obtained on arrival at the market and the day of lay in the farm (8.75) was close to 7.6-8.5 recommended by http://www.thepoultrysitecom/pulications. The values of 8.67-9.00 obtained in weeks 1-3 which were not significantly different (except in the 4th week, 4.50) of storage agreed with the above author who stated that during storage, the albumen pH increases at a temperature dependent rate to a maximum

value of about 9.7. This increase is said to result because of loss of CO_2 through the shell pores which depended on dissolved CO_2. It therefore implied that there was no deterioration of the gelatinous structure of the albumen during the first three weeks, this made the eggs to have firm, thick albumen. The albumen pH of 4.50 obtained in eggs stored for 4 weeks showed that there were changes in the complex lysozyme-ovomucine of the albumen caused by the high pH during the storage as stated by [23]. Thus, the egg will not be good for consumption. The yolk pH of 6.05 - 7.00 obtained in this study (except in week 4 with pH of 3.50) was similar to http:/www.the poultrysite.com/publications who reported that the yolk pH in newly laid egg is 6.0 and gradually increases to 6.4 - 6.9 during storage.

3.6 Interactive effect of colour and source on the internal characteristics

The interactive effect of colour and source on internal characteristics of eggs (Table 6) indicated that there were significant differences ($p<0.05$) in the internal characteristics. This showed clearly that the brown eggs had better quality than the white eggs. It was obvious from this work that despite the source of the white eggs, their internal qualities (yolk weight, yolk height, yolk ratio, yolk P^H, albumen weight, albumen height, albumen P^H and haugh unit) were significantly lesser than the brown eggs. This goes a long way to confirm why some buyers prefer brown to white eggs. This finding collaborate with that of [6] who stated that brown egg have been perceived by consumers to be more natural and healthy than white eggs. Consequently, [24] stated that the shell colour of brown is a quality aspect that is important for perception of the consumer. The HU of 39 obtained from white eggs from both the farm and the market was below the value of 40, so they could be termed inferior eggs according to [10] who termed eggs with HU of 57.95-61.86 to be high quality and those less than 40 to be inferior.

IV. CONCLUSION

This study showed that there were significant differences based on colour in some external qualities and all the internal qualities measured. The length of storage also significantly affected the egg weight, egg shape index and all the internal characteristics studied, such that the eggs stored beyond 3 weeks showed significant deterioration leading to poor haugh unit. The interaction between the colour and sources of egg affected the internal characteristics, such that the eggs stored beyond 3 weeks showed significant deterioration in the white eggs. This study therefore showed that eggs can be stored at room temperature for 3 weeks (21 days) in a warm humid environment. Policies which will support the consumption of eggs within 3 weeks of lay and its removal from the counters in the market and shops after same period should be enacted.

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Table 1: Effect of colour and source on the external characteristics of egg

Parameter	Colour		Source		
	Brown	White	Farm	Market	
Egg weight (g)	58.80±0.94	59.80±0.62	58.93±0.78	59.03±0.84	
Egg length (cm)	5.65±0.02[b]	5.83±0.19[a]	5.74±0.03[a]	5.74±0.04[a]	
Egg width (cm)	4.34±0.05	4.35±0.02	4.31±0.03	4.37±0.05	
Shell weight (g)	5.93±0.17	5.90±0.18	5.90±0.18	5.93±0.17	
Shell thickness (mm)	0.43±0.01	0.40±0.02	0.43±0.02	0.41±0.02	
Egg shape index	76.84±0.93[a]	74.60±0.61[b]	75.20±0.72[ab]	76.20±0.88[a]	

a,b = means within each row that bear different superscripts differ significantly

Table 2: Effect of the length of storage on the external characteristics of egg

Duration	Egg weight (g)	Egg length (cm)	Egg width (cm)	Shell weight (g)	Shell thickness (mm)	Egg shape index	
Day 1 of lay/ Arrival	60.75±1.33[a]	5.74±0.04	4.30±0.06	6.17±0.27	0.45±0.02	74.98±1.38[b]	
Week 1	59.67±1.33[a]	5.83±0.07	4.28±0.03	6.25±0.33	0.33±0.03	73.73±0.74[b]	
Week 2	59.67±1.07[a]	5.66±0.04	4.45±0.10	6.00±0.28	0.46±0.01	78.64±1.64[a]	
Week 3	59.58±1.28[a]	5.76±0.05	4.40±0.05	5.58±0.99	0.39±0.05	76.50±1.16[b]	
Week 4	57.00±1.15[b]	5.72±0.06	4.28±0.04	5.58±0.15	0.45±0.02	74.76±0.95[b]	

a,b = means within each column that bear different superscripts differ significantly

Table 3: Interactive effect of colour and source on the external characteristics of egg

Source	Colour	Egg weight (g)	Egg length (cm)	Egg width (cm)	Shell weight (g)	Shell thickness (mm)	Egg shape index	
Farm	Brown	57.73±1.31	5.69±0.03	4.26±0.20	5.87±0.22	0.45±0.02	74..90±1.12	
	White	60.13±0.79	5.79±0.05	4.37±0.13	5.92±0.28	0.41±0.02	75.60±0.93	
Market	Brown	58.42± 1.38	5.61±0.04	4.42±0.34	6.00±0.26	0.41±0.02	78.80±1.32	
	White	59.47±0.98	5.87±0.04	4.32±0.10	5.87±o.24	0.40±0.03	73.60±0.72	

Table 4: Effect of colour and source on the internal characteristics of egg

Parameters	Colour		Source		
	Brown	White	Farm	Market	
Yolk weight (g)	15.73±0.34^{a}	13.83±1.38^{b}	14.87±1.02^{a}	14.60±1.05^{a}	
Yolk height (cm)	4.03±0.05^{a}	3.34±0.32^{b}	3.67±0.23^{ab}	3.70±0.25^{ab}	
Yolk ratio	27.08±0.51^{a}	23.30±2.37^{b}	25.64±1.74^{ab}	24.75±1.76^{b}	
Yolk pH	7.27±0.16^{a}	5.90±0.57^{b}	6.70±0.46^{a}	6.50±0.41^{a}	
Albumen weight (g)	33.83±0.68^{a}	25.77±2.46^{b}	29.33±1.90^{a}	30.27±1.90^{a}	
Albumen height (cm)	3.39±0.07^{a}	2.68±0.26^{b}	3.05±0.20^{a}	3.02±0.20^{a}	
Albumen pH	9.00±0.01^{a}	6.97±0.66^{b}	8.10±0.50^{a}	7.87±0.50^{a}	
Haugh unit	51.53±0.82^{a}	37.18±3.75^{b}	45.57±2.95^{b}	45.15±2.91^{b}	

a,b,c = means within each row that bear different superscripts differ significantly

Table 5: Effect of the length of storage on the internal characteristics of egg

Duration	Yolk weight (g)	Yolk height (cm)	Yolk ratio	Yolk pH	Albumen weight (g)	Albumen height (cm)	Albumen pH	Haugh unit
Day 1 of lay/ Arrival	14.33±0.67^{b}	3.72±0.17^{b}	23.96±1.02^{b}	6.05±0.39^{a}	34.58±1.50^{a}	3.73±0.10^{a}	8.75±0.25^{a}	54.88±1.08^{a}
Week 1	17.58±0.62^{a}	3.96±0.10^{b}	28.99±0.99^{a}	6.83±0.11^{a}	34.33±1.16^{a}	3.46±0.11^{b}	9.00±0;00^{a}	51.70±1.10^{b}
Week 2	16.17±0.94^{ab}	4.38±0.10^{a}	28.33±1.53^{a}	7.00±0.00^{a}	31.67±0.99^{b}	3.25±0.12^{b}	9.00±0.00^{a}	49.16±1.56^{c}
Week 3	17.17±0.78^{a}	4.38±0.05^{a}	29.78±1.29^{a}	7.00±0.00^{a}	32.08±0.99^{b}	3.23±0.08^{b}	9.01±0.78^{a}	48.33±0.81^{c}
Week 4	8.67±2.62^{c}	2.08±0.63^{c}	14.93±4.53^{c}	3.50±0.06^{b}	16.33±0.97^{c}	1.50±0.00^{c}	4.50±4.70^{b}	22.73±6.88^{d}

a,b,c,d = means within each column that bear different superscripts differ significantly

Table 6: Interactive effect of colour and source on internal characteristics

Source	Colour	Yolk weight (g)	Yolk height (cm)	Yolk ratio	Yolk pH	Albumen weight (g)	Albumen height (cm)	Albumen pH	Haugh unit
Farm	Brown	15.60±0.43^{a}	4.01±0.08^{a}	27.13±0.29^{a}	7.53±0.29^{a}	33.07±1.02^{a}	3.34±0.07^{a}	9.00±0.00^{a}	57.38±5.44^{a}
	White	14.63±2.00^{b}	3.32±0.45^{b}	24.15±3.38^{b}	5.87±0.87^{b}	25.60±3.46^{b}	2.75±0.38^{b}	7.20±0.96^{b}	39.30±5.44^{b}
Market	Brown	15.87±0.53^{a}	4.05±0.07^{a}	27.03±0.62^{a}	7.00±0.09^{a}	34.60±0.89^{a}	3.43±0.12^{a}	9.00±00^{a}	51.23±1,33^{a}
	White	13.33±2.00^{b}	3.36±0.48^{b}	22.47±3.43^{b}	5.93±0.81^{b}	25.93±3.62^{b}	2.61±0.36^{b}	6.73±3.61^{b}	39.07±5.30^{b}

a,b = means within each column that bear different superscripts differ significantly