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Quality and chemical composition of chicken eggs as affected by storage duration and method

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ABSTRACT

The research was designed to evaluate the effect of storage duration and method on the quality and chemical composition of eggs. One hundred and fifty eggs obtained from 30 - weeks old Lowman Brown hens were used for the study. Storage methods and durations employed were: zero storage (M_1), 7 days refrigeration (M_2), 14 days refrigeration (M_3), 7 days room storage (M_4) and 7 days room storage of petroleum jelly - coated eggs (M_5). Quality parameters measured were egg weight (EW), shell weight (SW), Shell thickness (ST), yolk weight (YW), yolk height (YH), Yolk diameter (YD), albumen weight (AW), Albumen height (AH) and albumen diameter (AD). Others were yolk index (YI) and Albumen index (AI). The chemical components of the egg studied were crude protein (CP), ether extract (EE), ash, nitrogen free extract (NFE). Results showed that eggs of M_2 and M_4 were significantly ($p<0.05$) higher in YH, YI, AH and AI than those under the other storage methods. Eggs under M_5 were significantly ($p<0.05$) highest

in crude protein and ash content than other methods. On the other hand, eggs stored at room temperature for 7 days exhibited significant ($p<0.05$) superiority in potassium and sodium content than other methods. It was concluded that chicken eggs should not be stored above 7 days either under room storage or refrigeration in order to maintain their optimum condition of freshness.

Keywords: Chicken eggs, storage method, duration, quality, chemical composition

1. INTRODUCTION

Egg production is on the increase in Nigeria and poor storage conditions may result in deterioration in quality and a resultant loss and waste of eggs. According to Tayeb (2012), the value of an egg is determined by standards based on interior and exterior characteristics of individual eggs to reflect both the quality and size of the egg. Thick and firm albumen and yolk are indicators of high quality eggs. Stadelman and Cotterill (2005) asserted that factors such as, egg weight loss, shape index, yolk index, albumen height , haugh unit and shell thickness, were indicators to judge the edible value of eggs. The egg is one of the most nutritious foods of man. It has a balance of nutrients, especially the essential amino acids, in sufficient amounts and proportion for growth and maintenance of life (Rickets, 1981). The egg is a very perishable food product which can lose its quality rapidly during the period between storage and consumption (Mukul Asher and Stuti Rawat, 2017). Storage temperature and duration are among the principal determinants of quality of table eggs. The functional properties of eggs such as foaming, emulsifying and gelling could be altered if the quality of the egg deteriorates based on the storage method. This alteration could result to reduction in the proximate composition and loss of mineral components of the egg. During the storage period, a number of chemical and physical changes occur (Whitney and Rolfes, 1999). Some of these changes include thinning of the thick albumen and flattening of the yolk (Tayeb, 2012). These changes are used for the determination of quality indices of the eggs.

External qualities like cleanliness, weight and freshness go a long way in influencing consumers' acceptability of shell egg, whereas, internal qualities such as yolk and albumen indices and chemical composition of eggs may affect their personal and industrial usefulness. According to Jones and Musgrove (2005), high internal egg quality is important to egg product manufacturers because it allows for better separation of components without cross over contamination, especially when producing albumen products.

In Nigeria, eggs are often stored under ambient conditions, from the farm to the market and to the consumer. During this period between storage and consumption, there is a rapid loss in quality. High storage temperature and dehydration have been identified as egg degrading factors (Hassan and Okur, 2009). Observable changes in the egg due to improper storage were reported to include: a change of thick albumen to watery albumen and flattening of the yolk as a result of the weakening of the vitteline membrane (Tayeb, 2012). The alteration in egg quality could result in the reduction in proximate composition, as well as loss of mineral contents of the egg. Choice of the most appropriate storage method and duration will go a long way to reducing wastage and improve the egg production – consumption level in Nigeria.

This study was designed to estimate the effect of different storage methods and storage duration on: the internal and external qualities of the eggs, the proximate composition of the eggs and to ascertain the method that best ensures optimum quality of the eggs.

2. MATERIALS AND METHODS

One hundred and fifty (150) eggs obtained from Lowman Brown hens at 30 weeks of age, were used for the research. The hens were raised in the Poultry Unit of The Teaching and Research Farm, Department of Animal Science, University of Calabar, Nigeria. Hens were reared on deep litter floor, fed *adlibitum* with commercial Layers' mash containing 16% crude protein. Adequate management practices and strict hygiene standards were observed. Storage methods/durations employed were: Zero storage (M_1) [control], 7 days refrigeration (M_2), 14 days refrigeration (M_3), 7 days room storage (M_4) and 7 days room storage after petroleum jelly- coating (M_5).

The eggs were carefully cleaned using soft sand paper and 30 eggs randomly assigned to each of the methods. Twenty (20) eggs per storage method were used for egg quality analyses, while 10 eggs each were used for proximate analyses. Eggs were placed in plastic egg trays and those for refrigeration were kept in the refrigerator (Samsung®) at 10ºC, while those for room storage were kept in a well ventilated room with average temperature of 29ºC. Coating involved rubbing the eggs evenly with petroleum jelly (Vaseline Blue Seal ®) before placing in trays and storing at room temperature.

Egg and shell weights were taken using an electronic weigh balance (Mettler®). Yolk diameter was measured with a vernier caliper. Shell thickness and albumen height were measured using a tripod micrometer. Yolk index was calculated as the ratio of yolk height to yolk diameter, and albumen index, a ratio of albumen height to albumen diameter. Crude protein content of the eggs was estimated by multiplying 6.25 by the nitrogen content determined by the Kjedahl method. Ether extract and ash were analyzed by Soxhlet extraction and 550ºC muffle furnace respectively. Data obtained from the study were subjected to analysis variance using the completely randomized design. Means were separated by Least Square Difference (LSD). All statistical analyses were carried out using the Genstat (2010) Computer Programme.

3. RESULTS AND DISCUSSION

Egg quality parameters of the eggs as affected by storage method and duration are presented in Table 1. Albumen weight and Shell weight were not significantly affected by storage methods/ duration. Values recorded within the ranges of 30.77 – 33.47 g (AW) and 6.93 – 7.23 g (SW). These figures are at variance with ranges (39.12 – 41.64g AW and 5.54- 5.95g SW) reported by Ogunwole *et al.* (2015). The YH, YD and YW as well as AH and AD were however significantly ($p<0.05$) influenced by storage methods/duration. Eggs in M1 were significantly higher in YH, YW and AH than eggs in the other storage method groups. This observation is consistent with the finding of Dudusola (2009), who asserted that the parameters for measuring quality traits of eggs are at maximum when the eggs are freshly laid and decreases with increased storage time. Jin *et al.* (2011) reported a similar trend of increasing yolk and albumen weights with longer storage duration of eggs. Raji *et al.* (2009) observed drastic deteriorations in AH (0.73 to 0.29 cm) and YH (1.68 to 0.97 cm) as duration of storage of eggs increased. Samli *et al.* (2005) recorded similar observations. Eggs in M_2 and M_4 were statistically similar ($p>0.05$) in terms of their YH and AH, but were significantly ($p<0.05$) higher than M_3 eggs. The duration of storage comes into play here, because there is a thinning of the yolk with time as a result of the degradation of glycoprotein ovomucin which characteristically exerts firmness to the yolk. M_3 eggs (1.54 and 0.61cm) were however not statistically ($p>0.05$) different from M_5 group (1.32 and 0.55cm) with respect to their YH and AH respectively. Ogunwole *et al.*(2015) recorded significantly different ($p < 0.05$) YH values (11.09 and 8.37 mm) and AH values (3.92 and 3.22 mm) for eggs stored at room temperature for 7 and 14 days respectively. The observation in the present research differs slightly with the report of Raji *et al.* (2009) who recorded significant differences in yolk and albumen heights between eggs stored under room temperature and those oiled. The difference between the finding of the present research and that of the authors could be due to the overlapping effect of storage method and duration of eggs used in this study.

Table 1 Egg quality parameters as affected by storage methods/durations

Storage methods	EW	YH	YD	YW	AH	AD	AW	SW	ST	YI	AI
M_1	57.96 ±1.28^{b}	1.74 ±0.04^{a}	3.68 ±0.07^{b}	18.50 ±0.48^{a}	0.78 ±0.02^{a}	7.16 ±0.12^{c}	32.85 ±1.07	7.23 ±0.18	5.30 ±0.14^{a}	0.47 ±0.01^{a}	0.11 ±
M_2	57.29 ±1.01^{b}	1.37 ±0.06^{c}	4.49 ±0.37^{a}	17.88 ±0.57^{b}	0.59 ±0.02^{c}	7.37 ±0.14	30.77 ±0.74	6.96 ±0.10	5.43 ±0.13^{a}	0.31 ±0.03^{c}	0.08 ±
M_3	59.16 ±0.77^{a}	1.54 ±0.03^{b}	4.00 ±0.17^{a}	19.33 ±1.06^{a}	0.61 ±0.03^{b}	7.77 ±0.13^{a}	31.61 ±0.73	7.36 ±0.15	5.03 ±0.13^{a}	0.39 ±0.01^{b}	0.08 ±
M_4	56.73 ±1.02^{b}	1.55 ±0.02^{b}	4.03 ±0.05^{a}	16.77 ±0.32^{c}	0.57 ±0.02^{c}	7.83 ±0.09^{b}	33.47 ±0.88	7.02 ±0.14	5.23 ±0.13^{a}	0.38 ±0.02^{b}	0.07
M_5	55.40 ±0.84^{bc}	1.32 ±0.05^{c}	4.21 ±0.16^{a}	17.94 ±0.32^{b}	0.55 ±0.33^{c}	7.72 ±0.15^{ab}	30.85 ±0.61	6.93 ±0.13	4.67 ±0.32^{b}	0.31 ±0.02^{c}	0.07 ±

a,b,c : means on the same column with different superscripts are significantly different ($p<0.05$)

M_1= zero storage, M_2 = 7 days refrigeration, M_3 = 14 days refrigeration, M_4 = 7 days room storage, M_5 = 7 days room storage of petroleum jelly - coated eggs. EW = egg weight, YH = yolk height, YD = yolk diameter, YW = yolk weight, AD = albumen diameter, AW = albumen weight, SW = shell weight, ST = shell thickness, YI = yolk index, AI = albumen index.

Storage methods	Crude protein (%)	Ether extract (%)	Ash (%)	NFE (%)
M_1	21.87^{c}	27.75^{b}	1.00^{b}	4.38^{b}
M_2	32.81^{a}	29.75^{ab}	1.00^{b}	3.33^{b}
M_3	29.93^{b}	30.75^{a}	1.00^{b}	8.32^{a}
M_4	29.94^{b}	30.25^{a}	2.00^{a}	7.81^{a}
M_5	35.18^{a}	29.00^{b}	2.00^{a}	3.82^{b}
SEM	0.53	0.52	0.25	0.92

a,b,c : means on the same column with different superscripts are significantly different ($p<0.05$) . SEM = standard error of mean, NFE = Nitrogen free extract.

M_1 = zero storage, M_2 = 7 days refrigeration, M_3 = 14 days refrigeration, M_4 = 7 days room storage, M_5 = 7 days room storage of petroleum jelly - coated eggs.

Yolk index is an indication of freshness of the egg, the higher the index, the more desirable the egg quality. The YI of M_2 eggs were not significantly ($p<0.05$) different fromM_4 group, but were significantly higher than those of the M_3 group. YI of the later group (M_3) is similar to those in M_5. Whitney *et al.* (1999) noted that flattening of the yolk and thinning of the albumen were indicators of ageing and egg spoilage. This implies that after 7 days of storage, either in room or refrigerator, YI begins to deteriorate leading to spoilage. The YI of eggs in M_2 (7 days refrigeration) recorded in the present study (0.39) is similar to the value (39%) reported by Tayeb (2012) for eggs refrigerated for 9 days. Similarly, 0.38 recorded for M_4 (7 days room storage) egg in this research corresponds with 38.09% reported by Tayeb (2012). Similarly, Raji *et al.* (2009) reported steadily decreasing values of YI and AI with increasing duration of storage of eggs.

Fluctuation in EW among the storage groups was observed, which varies with the reports of Raji *et al.* (2009) and Dudusola (2009) that egg weight decreased progressively from lay as duration of storage increases. On the contrary, Ogunwole *et al.* (2015) observed a non- significant change in EW as duration of storage progressed.

Results of the chemical composition of eggs under different storage methods and duration are presented in Table 2. Temperature as well as duration of storage affected the chemical composition of chicken eggs. Freshly laid eggs (M_1) were consistently significantly ($p<0.05$) lower in all the proximate components than those stored under various conditions and durations (M_2 to M_5). Crude protein content was significantly ($p<0.05$) highest in the M_5 eggs (35.18%) and M_2 group (32.81%). The range of crude protein content of eggs recorded in the present study (21.87 – 35.18 %) is within the range (28.5 – 35.18%) reported by Dudusola (2009) for quail eggs under different storage conditions. Ogunwole *et al* (2015) recorded CP% values of 11.45, 11.54 and 11.60 for chicken eggs stored for durations of 0, 7 and 14 days respectively. Refrigerating eggs for up to 14 days gave statistically ($p<0.05$) higher ether extract (30.75%) and nitrogen free extract (8.32%) than shorter durations of storage and room temperature storage. The finding of the present study with respect ether extract composition (27.75 – 30.75%) varies with the report (11.45 – 11.60%) of Ogunwole *et al.* (2015). On the other hand, ash content of the eggs was highest (2.00%) when coated with petroleum jelly (M_5) and when stored at room temperature for 7 days (M_4) than cold storage (refrigeration). It is imperative to assert that storage of eggs at room temperature enhanced their ash content. The ash content obtained in this research (1.0 – 2.0%) is similar to the ranges (1.02 -1.10% and 0.74 – 1.59%) reported by Song *et al.* (2000) in eggs of different poultry species and Kaewmanee *et al.* (2009) in fresh duck eggs.

4. CONCLUSION AND RECOMMENDATION

Based on the results of this research, it was concluded that chicken eggs stored either at room temperature or in a refrigerator for not more than 7 days still maintained their optimum internal qualities. However coating eggs with petroleum jelly and storing for 7

days at room temperature optimizes their crude protein and ash contents. When there are no refrigeration facilities available, chicken eggs are recommended to be consumed within 7 days after lay, to be assured of the reputation of their internal quality.

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