Effects of storage condition and length of storage time on the quality of eggs in Nigeria

Resumen. Efecto de las condiciones y la longitud del período de almacenamiento sobre la calidad de los huevos en Nigeria. Este estudio se realizó para observar el efecto de las condiciones y la longitud del período de almacenamiento sobre la calidad de los huevos en Nigeria. Se almacenó huevos a temperatura ambiente (30°C) y en refrigeración (5°C) por período desde 1 hasta 3 semanas. Basados en la pérdida de peso, las unidades Haugh, el índice de yema, el índice de albúmina, el grosor de la cáscara y la aceptación del huevo después de ocho semanas de almacenamiento, se recomienda que, bajo las condiciones de Nigeria, no se almacenan huevos a temperatura ambiente por más de una semana mientras que bajo refrigeración pueden mantenerse hasta por ocho semanas sin una pérdida apreciable en calidad

In Nigeria as in many other developing tropical countries, table eggs for sale are kept at room temperature conditions for periods varying between one week to even eight weeks before they are completely bought off by consumers. In some cases, road side egg sellers keep their eggs exposed to the sun. Under such environmental conditions it is possible that the eggs may appreciably go down in quality after some period of time. Fry and Newell (3) and Reinke *et al.* (6) emphasized the importance of storage condition on egg quality. With the larger production of eggs in Nigeria and the increase of table egg consumption as a protein source in the Nigerian diet, it is important to look at the effect of storage condition and length of storage time on the quality of eggs consumed. This study was therefore carried out to determine the loss in weight and quality which will occur when eggs are stored at room temperature conditions for periods ranging from one week to eight weeks as compared with those stored in the refrigerator for the same length of time.

Materials and methods

A total of two hundred eggs from laying birds of the Harco breed which had been in lay for about 3 months were collected on the same day from the University of Ife Teaching and Research Farm. Prior to the day of collection, all the birds had been maintained on the same laying ration. The eggs were immediately taken to the laboratory and each of them was weighed to the nearest gram. Sixteen of the eggs were removed and eight of them were broken out and used to estimate yolk index, albumen index, Haugh unit and shell thickness. The other eight were broken out and the contents pooled together were used to determine the moisture, crude protein and ash contents by the methods of the Association of Official Analytical Chemists (1).

Yolk index was estimated as the ratio of the width of the broken out yolk to the height multiplied by 100. The height was determined with a depth micrometer mounted on a tripod and the width with a measuring rule. Albumen index was determined by dividing the height of the dense albumen by the width, multiplied by 100. Height and width measurements were as in the yolk index determination. In measuring the height and width of the yolk and albumen, the egg was cracked and opened onto a flat glass surface. Haugh unit was computed as

$$\frac{(\log \text{white height}) \times 100 \times \text{weight.}}{56.7}$$

Shell thickness was measured with a paper thickness 'starret' gauge. The membrane from each shell was removed and the measurements taken from three points on each shell. The shell thickness value used for each egg was the average of the three measurements. The remaining one hundred and eighty-four eggs were divided into two groups of 92 eggs each. One group of 92 was stored at room temperature of about 30°C while the other group was stored in the refrigerator at about 5°C. At the end of each week eight eggs were picked from each group. They were weighed and the weight changes noted. Four from each group were broken out and used to estimate yolk index, albumen index, Haugh unit and shell thickness while the other four from the same group were broken out and the contents pooled and used for the determination of the moisture, crude protein and ash contents. After the measurements for week eight, the remaining eggs were given out to individuals for boiling and frying so as to ascertain the acceptability of the eggs after eight weeks of storage.

Results

The mean square values and levels of significance for the effect of storage condition (refrigerated or room temperature) are presented in Table 1. The results show that storage under room temperature significantly ($P < 0.01$) increased percentage weight loss and yolk index while it significantly ($P < 0.01$) reduced Haugh unit value, albumen index and ($P < 0.05$) ash content. The storage condition did not significantly affect moisture content, crude protein content and shell thickness. Shell thickness decreased (though non significantly) when the eggs were stored at room temperature.

The results of the effect of storage condition and length of storage time are presented in Table 2.

Table 1. Effect of storage of eggs in the refrigerator or under room temperature on egg quality characteristics.

Parameter estimated	Storage conditions		Mean square and level of significance
	Refrigerated	Room temperature	
Weight loss (%)	2.57	4.94	22.4913**
Yolk index	29.98	48.99	1164.5156**
Albumen index	81.77	34.28	204.9596**
Haugh unit	66.38	34.80	506.7366**
Shell thickness	51.08	49.62	8.5849n.s
Moisture content (%)	74.21	74.29	0.0240n.s
Crude protein (%)	13.66	12.59	1.5006n.s
Ash content (%)	1.03	0.98	0.0103*

Table 2. Effects of storage on egg quality characteristics.

Parameter estimated	Initial value	Storage* Condition	Storage duration (weeks)								SE of mean
			1	2	3	4	5	6	7	8	
Weight loss (%)	–	R	0.29^{a}	0.70^{a}	1.02^{b}	2.20^{d}	3.29^{e}	3.84^{f}	4.25^{g}	4.95^{h}	0.24
		U	1.46^{a}	2.18^{b}	3.33^{c}	4.16^{d}	5.66^{e}	6.55^{f}	8.12^{g}	8.05^{g}	0.39
Yolk index	21.23	R	19.83^{a}	20.99^{a}	21.03^{a}	21.93^{a}	20.98^{a}	21.95^{a}	20.27^{a}	20.59^{a}	0.64
		U	25.24^{a}	39.02^{ab}	43.88^{abc}	49.48^{bc}	54.39^{bc}	56.41^{bc}	60.97^{bc}	61.42^{bc}	2.68
Albumen index	93.51	R	91.63^{a}	87.02^{a}	74.16^{a}	77.57^{a}	82.76^{a}	74.43^{a}	88.62^{a}	80.41^{a}	9.33
		U	38.86	27.41	–	–	–	–	–	–	**
Haugh unit	74.49	R	68.29^{a}	65.85^{a}	63.49^{a}	65.82^{a}	67.00^{a}	65.26^{a}	70.97^{a}	64.22^{a}	4.69
		U	40.03	33.52	29.52	–	–	–	–	–	**
Shell tickness (mm)	0.62	R	0.59^{b}	0.58^{b}	0.57^{b}	0.53^{ab}	0.49^{ab}	0.48^{ab}	0.42^{a}	0.42^{a}	0.04
		U	0.58^{c}	0.58^{c}	0.56^{bc}	0.48^{ab}	0.45^{ab}	0.47^{ab}	0.42^{a}	0.43^{a}	0.02

* R and U denote storage in the refrigerator and at room temperature respectively

** Incomplete measurements because of the liquefied albumen.

a, b, c, d, e, f, g, h Means in the same row bearing different superscripts are significantly different from one another ($P < 0.05$).

Haugh unit

The Haugh was maintained at about the same value for the refrigerated eggs all through the eight weeks of storage. For the unrefrigerated eggs Haugh unit dropped sharply after one week of storage. The value for the unrefrigerated eggs after one week of storage never approached any of the values recorded for the refrigerated eggs all through the eight weeks of storage. Haugh unit measurements for the unrefrigerated eggs was stopped after 3 weeks of storage because of the very liquid nature of the albumen at this stage.

Yolk index

The same trend applied to the yolk index. After eight weeks of storage the yolk index was 20.59 for the refrigerated eggs while it was 61.42 for the unrefrigerated eggs. The value of yolk index for the unrefrigerated eggs after one week of storage was even higher than the value for the refrigerated eggs after eight weeks of storage. Whereas yolk index for the unrefrigerated eggs significantly increased as the storage period increased, the yolk index for the refrigerated eggs was not significantly affected as the period of storage increased. The yolk index value

after eight weeks of storage did not deviate much from the initial value before storage commenced.

Albumen index

Albumen index value was high all through the eight weeks for the refrigerated eggs. It was not significantly affected with increased storage time. For the unrefrigerated eggs, the albumen index value fell sharply after one week of storage and after two weeks of storage it could not be measured because the albumen was already liquefying.

Percentage weight loss

The length of storage time significantly ($P < 0.01$) increased the percentage weigh loss. As the storage time increased the percentage weight loss increased both for the refrigerated and the unrefrigerated eggs. However the percentage loss was higher with the unrefrigerated eggs. Whereas unrefrigerated eggs lost 2.18% of their weight after two weeks of storage, the refrigerated eggs lost an equivalent value after 4 weeks of storage. After eight weeks of storage the refrigerated eggs had lost 4.95% of their weight while the unrefrigerated eggs had lost 8.05% of their weight.

Shell thickness

Shell thickness was significantly reduced with increased storage time. This was slightly more with the unrefrigerated than with the refrigerated eggs. Under each condition of storage, the drop in shell thickness became significant after the third week of storage.

Acceptability

Individuals who fried or boiled eggs after the eight weeks storage period found that the refrigerated eggs were acceptable while the eggs stored at room temperature showed unpleasant odour, the boiled yolk pushed towards the blunt end of the egg, discoloured albumen and were unacceptable for human consumption.

Discussion

The important point in this study is the effect of the storage condition and length of storage time on the different egg quality characteristics.

Haugh unit

One of the important interior quality measurements is the Haugh unit. The results of this study show that refrigeration of eggs preserved the Haugh unit value even when the eggs were stored for up to eight weeks. On the other hand at room temperature conditions in Nigeria, Haugh unit decreased appreciably when eggs were stored for even one week. This is important when it is realised that Haugh unit is a very good measure of egg interior quality which significantly correlates with most of the quality measurements (9). Trail (8) and Orr and Fletcher (5) have also reported reduced Haugh unit values for eggs stored at room temperature when compared to eggs stored under refrigerated conditions. The reduced Haugh unit values at room temperature storage (30°C) when compared to the values under refrigerated storage (5°C) could be related to the liquefied albumen of eggs stored at room temperature. With increased liquefaction of the albumen, the albumen height was reduced and therefore affected the Haugh unit values.

Yolk index and albumen index

From the definition used in this study in measuring the yolk index, the ratio of the width of the broken out yolk to its height, as the yolk became flatter with the storage period the value of the yolk index became larger for the poor quality eggs Using yolk index as a measure of quality, it means that cold temperature preserved quality even when the eggs were stored for up to eight weeks while room temperature storage rapidly decreased egg quality even with up to one week of storage. Albumen index which is another measure of quality decreased with storage under room temperature while it was not significantly affected by refrigeration. This is to be expected since under room temperature storage the height of the albumen significantly decreased while there was liquefaction which increased albumen width. Romanoff and Romanoff (7) had reported that the liquefaction of the albumen is due to the tendency for the mucin content of the dense albumen to decrease. It may therefore be that cold storage preserved the mucin content of the albumen while room temperature storage decreased it and therefore brought about decreased egg quality. Looking at the maintenance of the different quality criteria by cold temperature (5°C) storage when compared to room temperature storage (30°C), it is pertinent to note that Card and Nesheim (2) reported that a storage temperature of about 4.4°C is good for egg storage.

Weight loss

The greater loss in weight recorded in this study following room temperature storage has been reported by Romanoff and Romanoff (7) and Meyer and Spencer (4). The increased percentage weight loss of the eggs with room temperature storage may in

part have been caused by the lower shell thickness at room temperature storage than under refrigerated conditions. With reduced shell thickness there would probably be an increase in porosity of the shell leading to a greater loss of water and gases from the eggs. There was also a lower ash level of the eggs stored at room temperature.

Acceptability

The unpleasant odour after eight weeks of storage for the eggs stored at room temperature could be due to increased chemical changes of the egg content. Romanoff and Romanoff (7) indicated the production of H_2S from breakdown of egg contents when eggs are stored. Such production of H_2S and probably some other breakdown products might have been responsible for the unpleasant odour noted. The eggs stored in the refrigerator showed no such unpleasant odour and were still acceptable to individuals after eight weeks of storage. It therefore appears that storage under refrigerated conditions prevents or retards the rate of breakdown of egg contents.

From the results of this study and considering the different interior quality measurements, it appears that under the conditions in Nigeria, table eggs should not be stored at room temperature conditions for more than a week whereas storage in the refrigerator will permit the eggs to be kept for up to eight weeks without appreciable loss in quality.

Summary

An experiment was carried out to study the effects of storage condition and length of storage time on the quality of eggs in Nigeria. Eggs were stored either at room temperature (30°C) or in the refrigerator (5°C) for periods varying from one week to eight weeks. On the basis of percentage weight loss, Haugh unit, yolk index, albumen index, shell thickness and acceptability of the eggs after eight weeks of storage, it is recommended that under the conditions in Nigeria, table eggs should not be stored at room temperature for more than a week whereas storage in the refrigerator will permit eggs to be kept for up to eight weeks without appreciable loss in quality.

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