Effect of Storage on the Internal Quality, Physical Composition and Weights of Eggs

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SUMMARY

THREE experiments were conducted to investigate the effects of storage on the quality of eggs produced in Nigeria. It was observed that when eggs were stored at room temperature of 25.2°C for 4 weeks, a progressive weekly decline in Haugh units, yolk index and egg weights occurred. A much smaller decline in Haugh units and yolk index was observed when the eggs were stored in an air conditioned room at a temperature of 18.2°C. When the eggs were stored in the refrigerator for 4 weeks at 3.5°C the internal quality of the eggs was relatively preserved and a much smaller decline in egg weights occurred. Maximum albumen pH was attained within 3 to 4 days of storage in all cases. It was also observed that the albumen, as a percentage of egg contents, decreased with storage time but the largest decrease was observed with the eggs stored at room temperature.

INTRODUCTION

EGG production is on the increase in Nigeria. It is therefore necessary that more attention be placed on the storage and marketing of eggs. Poor storage conditions may result in deterioration in egg quality (Kumar *et al.*, 1969; Reinke *et al.*, 1973) and consequently loss and waste of eggs. In Nigeria, most of the eggs available are usually stored at room temperature (25°C) and, in very few cases, in air conditioned rooms (18°C) until they are completely sold or consumed. The period of storage may vary from several days to a few weeks. Only in very few cases are eggs stored in the refrigerator or in environments cooler than air

conditioned rooms, a practice usually confined to a few homes and not practised commercially. Quantitative data on these methods of storage are limited. Moreover, information on the quality of fresh eggs produced in Nigeria is also limited.

In order to be able to advise poultry farmers, egg retailers and consumers on the optimum length of storage time and best storage conditions, studies were initiated to obtain information on the effects of storage environment and storage time on egg quality. The results of the studies are presented in this paper.

MATERIALS AND METHODS

Chicken eggs used for these studies were obtained from the college poultry farm and were initially clean fresh eggs laid within eight hours of collection. The birds used were Cross bred (Rhode Island Red x White Leghorn) hens raised in battery cages and fed a commercial layers' diet. As soon as the eggs were collected, they were separated by weight in a commercial electrical egg grader ('EISO' 1600)¹ and only those eggs that fell within the medium range (average of about 49 gram) were used for the studies. Initially, 12 eggs were used for determining Haugh unit, yolk index and physical

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composition of the eggs. Another set of 6 eggs were used for determining the initial pH of the albumen. The remaining eggs were then divided into 3 groups, each group containing 100 eggs. Twelve eggs from each group were numbered and weighed individually at the start of the experiment and at weekly intervals and the percent weight loss of each egg was calculated every week. One group of 100 eggs was stored at room temperature; the second group was stored in an air conditioned room and the third group of 100 eggs was stored in the refrigerator. Each week, 12 eggs from each group were used for the determination of Haugh units, yolk index and, once every 2 weeks, physical composition of the eggs. Another set of 6 eggs from each group was used for determining pH of the albumen.

Two similar experiments, which involved measurements of the characteristics outlined above were carried out, each experiment lasting 4 weeks. A third experiment involved determination of Haugh unit, yolk index and albumen pH every day for 7 days in a manner similar to that used in experiments 1 and 2. The characteristics studied were determined as follows:

Haugh units (H. U.)

After weighing, the eggs were broken out on a smooth level surface and the albumen height determined, away from the Chalaza, at a point about midway between the inner and outer edges of the thick white. Haugh units were calculated using the formula:

$$\text{H. U.} = 100 \log (H - 1.7 W^{0.37} + 7.6)^1$$

where H is albumen height and W is weight of egg.

Yolk index (Y. I.)

The diameter and height of the yolk were measured, without the yolk being removed from the albumen. The ratio of yolk height to diameter was taken as the yolk index.

Physical Composition of eggs

The eggs used for determination of Haugh units and Yolk index were also used for determining composition of yolk and albumen. In the determination, the yolk was separated from the albumen and weighed. The weight of the albumen was obtained by difference. The weights of the yolk and albumen were then expressed as percentages of the egg contents.

pH measurements

Albumen pH values were determined using a Seibold glass electrode pH meter, Model GTB²:

During the experimental periods, the temperature and relative humidity of the storage environments were recorded every day.

All data were subjected to analyses of variance and significance of differences were assessed by applying Duncan's Multiple Range Test (Steel and Torrie, 1960).

RESULTS

Experiments 1 and 2

Since results obtained in Experiments 1 and 2 were similar, data obtained in both experiments were averaged and presented together in the tables.

Data on Haugh units and yolk index values are summarised in Table 1. There was a significant decline in Haugh unit

¹ According to "Egg Quality" published by the British Oil and Cake Mills Ltd.

² Wipplingerstrasse 24, 1010 Wien — Österreich, Austria.

TABLE 1
Haugh units [H.U.] and Yolk index [Y.I.] of eggs after different periods of storage under different storage environments: Experiments 1 and 2 combined

Storage environment	Duration of Storage									
	Initial		7 days		14 days		21 days		28 days	
Fresh	H.U.	Y.I.	H.U.	Y.I.	H.U.	Y.I.	H.U.	Y.I.	H.U.	Y.I.
Room ²	84.6	0.46	84.6a	0.46a	84.6a	0.46a	84.6a	0.46a	84.6a	0.46a
Air conditioned ³	84.6	0.46	76.4b	0.32b	73.9b	0.25c	72.3c	0.21b	69.3b	0.19c
Refrigerated ⁴	84.6	0.46	81.9ab	0.40a	75.3b	0.36b	75.7bc	0.32c	74.6b	0.29b
	84.6	0.46	84.1a	0.46a	84.6a	0.46a	83.1ab	0.45a	83.2a	0.45a

1 Column values with same superscript or no superscript are not significantly different ($P < 0.05$).

2 Room temperature = 25.2°C; Relative humidity = 61.7%.

3 Air conditioned temperature = 18.2°C; Relative humidity = 43.0%.

4 Refrigerated temperature = 3.5°C.

TABLE 2
Effect of storage environments on weight loss [W.L.] and pH of albumen of eggs after different periods of storage¹: Experiments 1 and 2 combined

Storage Environment	Duration of Storage									
	Initial		7 days		14 days		21 days		28 days	
Fresh	W.L. %	pH	W.L. %	pH	W.L. %	pH	W.L. %	pH	W.L. %	pH
Room ²	0.00	8.2	0.00	8.2a	0.00a	8.2a	0.00a	8.2	0.00	8.2a
Air Conditioned ²	0.00	8.2	1.13	9.3d	2.94b	9.3c	4.24b	9.3c	6.08c	9.3c
Refrigerated ²	0.00	8.2	1.06	9.1c	2.93b	9.2c	4.46b	9.3c	6.13c	9.3c
	0.00	8.2	0.25	8.9b	0.73a	8.9b	1.16a	9.0b	2.09b	9.0b

1 Column values with same superscript or no superscript are not significantly different ($P < 0.05$).

2 See Table 1.

and yolk index values within one week of storage at room temperature. There after, there was a progressive weekly decline in Haugh unit and yolk index values of eggs stored at room temperature. The Haugh unit and yolk index values of eggs stored in air conditioned room were significantly below those of fresh eggs only after 2 weeks of storage. Eggs stored in the refrigerator tended to retain the initial Haugh unit and Yolk index values throughout the 4 weeks experimental period. Data on weight loss (Table 2) showed a progressive weekly loss in weights of eggs stored under the different environments. However, only after 2 weeks of storage were the weights of eggs

tended to remain constant.

The percentage composition of the yolk and albumen is given in Table 3. There was a slight progressive non-significant increase in the percentage of yolk of eggs stored under the different environments; although the highest increase was noted in the eggs stored at room temperature. The slight decrease noted in the percentage of albumen became significant after two weeks of storage. The lowest percentage albumen was recorded with eggs stored at room temperature.

Experiment 3

Since the first two experiments showed that significant depreciation in Haugh

TABLE 3

Percentage composition¹ of Yolk and albumen as affected by different periods of storage under different storage environments²: Experiments 1 and 2 combined

Storage Environment	Duration of Storage					
	Initial		14 days		28 days	
	Yolk	Albumen	Yolk	Albumen	Yolk	Albumen
Fresh	35.8	64.2	35.8	64.2 ^a	35.8	64.2 ^a
Room ³	35.8	64.2	38.0	62.0 ^c	40.2	59.8 ^c
Air Conditioned ³	35.8	64.2	35.9	64.1 ^b	38.8	61.2 ^{bc}
Refrigerated ³	35.8	64.2	36.2	63.8 ^b	38.4	61.6 ^b

¹Yolk and albumen are expressed as percentages of egg contents (i.e. Weight of egg — weight of shell).

²Column values with same superscript or no superscript are not significantly different ($P < 0.05$).

³See Table 1.

stored at room temperature, or air conditioned, significantly below those of fresh eggs; while it took about 4 weeks for weights of eggs stored in the refrigerator to be significantly depressed below those of fresh eggs. There was also a significant initial rise in pH of Albumen after one week of storage under the three different environments, with the lowest increase being noted in those eggs stored in the refrigerator (Table 2). From one week of storage onwards, the pH of the albumen

units, yolk index and pH values occurred within one week of storage at room temperature, the third experiment was designed to study the daily variations in these egg characteristics up to seven days of storage. The results of this experiment are summarised in Table 4. The Haugh unit values of eggs were significantly depressed below those of fresh eggs within 2 days of storage at room temperature while it took about six days of storage at room temperature for the yolk index

TABLE 4

Haugh units, Yolk index and pH of albumen of eggs after different days of storage under different storage environments¹: Experiment 3

Day	Haugh Units			Yolk Index			pH of Albumen		
	Room ²	Air Cond. ²	Refrig. ²	Room	Air Cond.	Refrig.	Room	Air Cond.	Refrig.
0	86.3a	86.3a	86.3	0.44a	0.44	0.44	8.1a	8.1a	8.1a
1	81.8ab	83.3ab	85.4	0.43a	0.44	0.45	8.8b	8.7b	8.7b
1	78.4bc	81.2abc	85.7	0.42a	0.44	0.46	8.9bc	8.9bc	8.7b
3	76.9bcd	81.7ab	85.6	0.40ab	0.45	0.44	9.1bcd	9.0bc	8.8b
4	76.1cd	78.2bcd	81.8	0.40ab	0.41	0.44	9.2cd	9.1c	8.8b
5	75.3cd	76.1cd	81.2	0.37ab	0.41	0.45	9.2cd	9.0bc	8.8b
6	72.5d	77.4bcd	81.1	0.35bc	0.41	0.44	9.3cd	9.1c	8.9b
7	72.6d	75.1d	81.1	0.30c	0.39	0.44	9.2cd	9.2c	8.9b

¹ Column values with same superscript or no superscript are not significantly different ($P < 0.05$).

² See Table 1.

values to be significantly below those of stored in the refrigerator remained relatively similar to those of fresh eggs. There was a significant rise in pH values of albumen within 24 hours of storage in all cases. Thereafter, the rise in pH was slow up to the third or fourth day of storage when the pH values tended to remain stable.

DISCUSSION

The present studies indicate that fresh eggs produced in Nigeria are of high and comparable quality with fresh eggs produced in other parts of the world. The results also show that inadequate storage conditions may result in deterioration in the quality of eggs.

The differences in the ability of the three storage environments (room, air-conditioner and refrigerator) to maintain the Haugh unit and yolk index values of eggs may be related to the differences in the temperatures of the three storage environments. The lowest temperature was recorded in the refrigerator (3.5°C) and this environment retained a higher proportion of the original internal quality of eggs than an air conditioned room

(18.2°C), which in turn retained a higher proportion of the original quality of the egg than room temperature environment (25.2°C). Similar effects of temperature were recorded by Orr and Fletcher (1973) who reported that the Haugh unit value of eggs declined when the temperature was raised from 4.4°C to 12.8°C and further declined when the temperature was raised to 21.2°C. The above results thus suggest that eggs produced in Nigeria must be kept cool in order to retain a high proportion of the original internal quality. The temperature of the refrigerator is close to the storage temperature of 1.7°C to 4.4°C recommended by Card and Nesheim (1973) although higher temperatures (10° to 15°C) have been recommended (Orr and Fletcher, 1973).

The loss in weight when eggs were stored at room temperature was similar to that reported by Kumar *et al* (1969) and Meyer and Spencer (1973). Even at the lower temperatures of the air conditioned room and refrigerator, there were still some losses in weights of eggs. These losses in weights of eggs may be related to the increase in porosity of the shell of stored eggs and consequently an increase

in the rates of escape of water and gases from the stored eggs. This conclusion was reached because when the eggs were candled at the beginning and end of the experimental periods, the eggs appeared more porous at the end than at the beginning. Shell porosity was observed to be more pronounced with eggs stored at room temperature than those stored in the refrigerator. It seemed that the lower relative humidity recorded for the air conditioned room (43%) as compared to room temperature 61.7%) may have modified the influence of temperature on egg weight loss.

The increase in percentage of yolk during storage of eggs at room temperature is in agreement with the observations of Kumar *et al* (1969). This increase in percentage of yolk and consequently decrease in percentage of albumen may be due to transfer of water from albumen to yolk which resulted in the yolk, in the present studies, assuming a somewhat flattened shaped in the case of eggs stored at room temperature. The present results also suggested that the major change in pH of albumen occurred within 24 hours of storage, an observation consistent with the findings of Meyer and Spencer (1973). This result suggests that for studies involving changes in pH of egg albumen, the initial pH should be recorded as soon as possible, after the eggs have been laid.

From the above results, it would seem reasonable to suggest that in parts of Nigeria where cold storage facilities are not readily available, eggs should be sold within one week of gathering to avoid appreciable loss in internal quality of eggs. This recommendation is not in agreement with that given by Thomann (1972) who suggested that in tropical areas, infertile eggs keep their quality at ambient temperatures for at least 10 days to two weeks. For eggs which are to be kept

for more than 1 week, cold storage is recommended. It seems however that a compromise temperature between that of the refrigerator (3.5°C) and that of the air conditioned room (18.2°C) must be sought since eggs stored in the refrigerator tended to "sweat" on being removed and kept for some time at room temperature.

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REFERENCES

- CARD, L.E. and NESHEIM, M.C. 1973. Poultry production, p. 297. Philadelphia, U.S.A. Lea and Febiger.
- KUMAR, S., PANDA, B., SREENIVASULU, M. and RAO, R.J. 1969. Studies on the comparative efficacy of oil coating and lime-sealing on the preservation of shell eggs at room temperature. *J. Food Sci. Technol.* 6: 9-11.
- MEYER, R. and SPENCER, J.V. 1973. The effect of various coatings on shell strength and egg quality. *Poultry Sci.* 52: 703-711.
- ORR, H.L. and FLETCHER, D.A. 1973. Eggs and Egg Products. Publication 1498, Canada Department of Agriculture.
- REINKE, W.C., SPENCER, J.V. and TRYHEW, L.J. 1973. The effect of storage upon the chemical, physical and functional properties of chicken eggs. *Poultry Sci.* 52: 692-702.
- SPENCER, J.V. and TRYHEW, L.J. 1973. Effect of storage on peeling quality and flavour of hard-cooked shell eggs. *Poultry Sci.* 52: 654-657.
- STEEL, R.G.D. and TORRIS, J.H. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Company Inc., New York, Toronto, London.
- THOMANN, W. 1972. Poultry keeping in Tropical Areas, p. 2. Rome, Food and Agricultural Organization of the United Nations.