Effects of Storage Methods and Length of Storage on some Quality Parameters of Japanese Quail Eggs

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Summary

Quality parameters of Japanese quail eggs, as affected by storage method and length in 21days, were assessed using 140 eggs collected from 7-week old birds. Eggs were stored using refrigeration, oiling, black polythene bag or on a tray at room temperature (30 °C) as a control. This study determines the best storage condition and optimum storage length storage for quail eggs. Egg quality parameters measured included egg weight, shell weight, yolk height, albumen height, yolk index, haugh unit and egg weight loss. Effects on the chemical composition of eggs were determined with proximate analysis. Data were analysed using analysis of variance (ANOVA) with storage method and duration as the two main effects. There were progressive increases in weight losses with increased length of storage for all storage methods. Haugh units decreased progressively per storage method as length of storage increased (P< 0.05). Control and refrigeration methods do not differ significantly in all proximate composition except for protein. There were significant differences (P< 0.05) in length of storage for all proximate composition. Eggs maintained desired internal quality when stored for 4 days at room temperature. Refrigeration could be used for storage of eggs up to 7 days; where it is unavailable oiling could be used.

Résumé

Effets de méthodes et durée de stockage sur certains paramètres de qualité des œufs de cailles japonaises

Les effets des méthodes et durée de stockage en 21 jours sur des paramètres de qualité d'œufs de cailles japonaises étaient analysés à l'aide de 140 œufs provenant d'oiseaux âgés de sept semaines. Les œufs étaient stockés par la méthode de réfrigération, l'huilage, et l'usage du sachet noir de polythène. Le stockage sur un plateau à la température ambiante (30 °C) servant de témoin. Cette étude vise à déterminer la meilleure méthode et la durée optimale de stockage des œufs de caille japonaise. Les paramètres de qualité observés incluaient: le poids de l'œuf, le poids de la coquille, la hauteur du jaune, la hauteur de l'albumen, l'indice de jaune, l'unité Haugh et la perte de poids de l'œuf. Les effets sur la composition chimique de l'œuf étaient déterminés par l'analyse rapprochée. Les données sont analysées par l'analyse de variance (ANOVA); la méthode et la durée de stockage étant les deux principaux facteurs. Les résultats indiquent une perte progressive de poids avec la durée de stockage et pour toutes les méthodes de stockage. Les unités Haugh diminuaient progressivement par méthode de stockage à mesure que la durée de stockage augmentait. En terme de composition chimique, le témoin et la méthode de réfrigération ne présentent pas de différence significative à l'exception de la protéine. Il est observé des différences significatives (p< 0,05) de composition chimique pour différentes durées de stockage. Les œufs maintiennent des qualités internes désirées lorsqu'ils sont stockés pendant quatre jours à la température ambiante. La réfrigération peut être utilisée pour des courtes durées de stockage jusqu'à sept jours maximum, mais là où cette méthode n'est pas disponible l'huilage est la méthode de choix.

Introduction

The significance of protein from animal protein sources such as poultry in sufficient and balanced nourishment is considerable for the human health with respect to the physical and mental progress (12, 19). Eggs provide means through which the animal protein of the populace can be met. It has various uses and contains many essential nutrients as it supports life during embryonic growth (17) and one of the most nutritious and complete food known to man. However, egg quality characteristics, utilization for food, storage and other purposes have been studied mostly in chicken egg.

Egg quality is composed of those characteristics of an egg that affect its acceptability to consumers, it is therefore important that attention is paid to the problems of preservation and marketing of eggs to maintain the quality (1, 18). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer's acceptability of shell eggs. On the other hand, interior characteristics such as yolk index, haugh unit, and chemical composition are also important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (17). Eggs deteriorate in internal quality with time and this is depending on the shell and internal content of the egg (1, 13). Poor storage conditions may result in deterioration of egg quality and consequently loss and waste of eggs. There are reports which show that loss of water through pores, prevention of microorganism invasion and lower temperature are major considerations of retarding quality degradation. Since storage environment influence the quality of eggs, methods like lower temperature and modified atmosphere packaging such as refrigeration have been recommended (8).

This study investigates the effect of storage environment and storage time on egg quality so that quality advice can be given to quail farmers, egg retailers and consumers on the optimum length of storage as well as the best storage method.

Material and methods

A total of 140 freshly laid Japanese quail eggs of almost equal size were obtained from 7-week old Japanese quail

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(*Cortunix cortunix japonica*) at NIFAGOL farm, Ipetumodu, Osun state, Nigeria. The birds were reared on deep litter and fed with a layer ration containing 24% crude protein.

Evaluation of egg quality
140 eggs were randomly selected and divided into five groups comprising of 35 eggs per group. Each group was allotted to a treatment and was further divided into 5 sub-groups to assess the effect of length of storage on the eggs at 0, 4, 7, 14 and 21 day for each of the following storage methods (treatments):

a. Refrigeration: eggs were arranged on egg trays and stored in a refrigerator (Thermocool®) at 10 °C and 86% relative humidity (1)
b. Oiling: eggs were immersed in groundnut oil, allowed to drain for some seconds and stored at room temperature (32 °C) on a flat surface
c. Black polythene bag: egg were placed in a black nylon bag each with its mouth tied and stored at room temperature (1)
d. Room temperature (control): eggs were placed in egg tray untreated and stored at room temperature (32 °C) and 61% relative humidity.

Egg quality parameters (external and internal) were measured at 0, 4, 7, 14 and 21 days. Eggs were broken out on a flat transparent glass surface using a spatula to obtain various internal parameter measurements. Day zero (0) measurements were used as the control for length of storage for each storage method.

The external quality parameters measured were:

i. Egg and shell weights (in grams) at 0, 4, 7, 14 and 21 days for the storage methods using a weight balance (7)
ii. Shell surface area (SSA) was determined from this expression:
$SSA= 3.9782 (SW^{0.7062})^5$ (7) where SW= Shell weight
iii. Shell density (SD) was estimated from the expression:
$SD=SW / (SW \times ST)^5$ (7) where ST= Shell Thickness

The internal quality parameters measured for all the 35 eggs in each storage method on each day of observation were:

i. Yolk height, yolk width and albumen height (in cm) using a caliper.
ii. Yolk index was estimated from ratio of yolk height to yolk width.
iii. Haugh units were determined from albumen height and egg weight using the expression below:
$HU= 100\log (H + 7.51 - 1.7EW^{0.37})^2$ (9)
where H= Albumen height (cm) , W= the weight of egg when tested (g)
iv. Egg weight loss was determined as the difference between successive weights of eggs at different weighing days.

Analytical methods
Moisture content was determined by drying in hot air oven at 100-102 °C for 16-18 hours (2). Crude protein was estimated by multiplying 6.25 to nitrogen content obtained through Kjeldahl method (2). Ether extract and ash were analysed by soxhlet extraction (2) and 550 °C muffle furnace, respectively.

Statistical analysis
Data collected was subjected to analysis of variance with storage methods and duration of the storage as the two main effects. Means were subsequently separated using Duncan's Multiple Range Test (Duncan, 1955).

Results

There was significant difference in egg weights (Table 1) for all storage methods throughout the duration of storage. In the control, egg weight at day 0 was significantly different (P< 0.05) from day 7. Egg weight at day 0 for refrigeration was not significantly different (P< 0.05) from day 4 but differs significantly from days 14 and 21. In the oiling method, egg weights at day 0, 4, 7 and 14 were not significantly different but days 0, 4 and 7 were significantly different from day 21. Days 0, 4, and 7 for black polythene were not significantly different but day 14 differs significantly from day 21.

Average weight losses (Table 1) increased with increased storage length for all storage methods. There were significant differences (P< 0.05) in egg weight loss throughout the 21 days of storage for all storage methods except on days 7 and 14 for oiling method that show no significant difference. Eggs in intensely oiled experienced the lowest weight losses and this was followed by eggs stored in the refrigerator. Highest weight losses were recorded for eggs used as control.

Haugh units decreased progressively per storage method as the length of storage increased (Table 1). There was a significant difference (P< 0.05) between storage condition and storage duration. There was no significant difference (P> 0.05) in haugh units of day 0 and day 4 in the control (room temperature) and refrigeration methods though day 0 was significantly different from day 7, 14 and 21 for both methods. There was no significant difference in haugh units of day 0, 4 and 7 in oiling and black polythene bag methods. However day 7 of both methods is significantly different from day 14 and day 21.

Yolk indices in duration for all storage methods were significantly different (P> 0.05) (Table 1).

From day 4 to day 21, yolk indices for control (room temperature) differ significantly from refrigeration method. At day 4, oiling method was not significantly different from black polythene bag method and control, but control differs significantly from black polythene bag method. From day 7 to day 21, oiling differ significantly from black polythene bag.

Table 2 shows the proximate composition of dried open quail egg. Control and refrigeration method do not differ significantly in all the proximate composition except for protein, similarly oiling and black polythene bag methods do not differ significantly. However, there were significant differences in length of storage for all the proximate composition as shown on table 3.

Discussion

The parameters for measuring the quality traits of all eggs are at maximum when the eggs are freshly laid and decrease with increased storage time (16). Therefore storage conditions are chosen with regard to the retention of these quality traits. Temperature, relative humidity and flow of air or moisture are considered as the main factors in determining the technological conditions for storing eggs (14).

With increase in length of storage, egg weights declined as a result of increase in weight losses. The losses could be due to loss of carbon dioxide, ammonia, nitrogen, hydrogen sulphide gas and water from the eggs (10). Weight losses were not the same for all storage methods. Eggs oiled and refrigerated did not lost as much solvent as those in polythene bag and control. Thus, reduction in quality parameters was not as high in refrigeration and oiling as in black polythene bag and control. The low weight loss of oiled eggs may be due to blockage of shell pores by thin films of oil thus preventing water or gaseous escape.

Haugh unit and yolk indices are generally considered as good indicators to evaluate egg quality (8). The higher the yolk index (3) and the haugh unit (10), the more desirable the egg quality. The variations in these values for fresh quail eggs and eggs stored for 21 days under room temperature,

Table 1
Average Haugh Units, Yolk Indices, Weight and Weight Loss of quail eggs under different storage conditions

Parameter	Storage Condition	Duration of Storage (Days)					SEM
		0	4	7	14	21	
Haugh Unit	Room temperature (Control)	57.4^{a}_{y}	56.0^{ab}_{z}	54.5^{bc}_{z}	54.0^{c}_{w}	53.8^{c}_{z}	0.5
	Refrigeration	62.1^{a}_{x}	61.1^{ab}_{x}	59.5^{bc}_{x}	58.5^{c}_{x}	58.4^{c}_{x}	0.5
	Oiling	58.6^{a}_{y}	58.3^{a}_{y}	58.2^{a}_{xy}	57.3^{b}_{y}	55.8^{c}_{y}	0.3
	Black polythene bag	58.6^{a}_{y}	57.9^{a}_{y}	57.7^{a}_{y}	55.8^{b}_{z}	53.6^{c}_{w}	0.3
SEM		0.4	0.3	0.4	0.3	0.5	
Yolk Index	Room temperature (Control)	0.4^{a}_{x}	0.3^{b}_{z}	0.2^{c}_{z}	0.1^{d}_{z}	0.1^{d}_{z}	0.0
	Refrigeration	0.4^{a}_{x}	0.3^{b}_{x}	0.3^{c}_{x}	0.3^{d}_{x}	0.3^{d}_{x}	0.0
	Oiling	0.4^{a}_{x}	0.3^{b}_{yz}	0.3^{b}_{y}	0.2^{c}_{y}	0.2^{d}_{y}	0.0
	Black polythene bag	0.4^{a}_{x}	0.3^{b}_{y}	0.3^{c}_{y}	0.2^{d}_{y}	0.2^{e}_{y}	0.0
SEM		0.0	0.0	0.0	0.0	0.0	
Egg Weight	Room temperature (Control)	11.8^{b}_{x}	12.1^{ab}_{x}	13.0^{a}_{x}	12.3^{ab}_{x}	12.1^{ab}_{y}	0.2
	Refrigeration	11.4^{b}_{y}	9.9^{bc}_{z}	10.8^{ab}_{y}	11.4^{a}_{y}	11.3^{a}_{y}	0.3
	Oiling	11.4^{ab}_{x}	11.3^{b}_{y}	11.1^{b}_{y}	11.5^{ab}_{y}	12.0^{a}_{y}	0.1
	Black polythene bag	11.4^{bc}_{x}	11.3^{c}_{y}	11.2^{c}_{y}	12.0^{b}_{xy}	3.1^{a}_{x}	0.2
SEM		0.2	0.2	0.2	0.2	0.2	
Weight Loss	Room temperature (Control)	-	1.2^{d}_{x}	2.8^{c}_{x}	3.9^{b}_{x}	5.4^{a}_{x}	0.2
	Refrigeration	-	0.2^{d}_{y}	0.5^{c}_{y}	1.2^{b}_{z}	2.0^{a}_{y}	0.0
	Oiling	-	0.0^{c}_{y}	0.1^{bc}_{y}	0.2^{b}_{w}	0.4^{a}_{z}	0.0
	Black polythene bag	-	0.1^{d}_{y}	0.7^{c}_{y}	1.9^{b}_{y}	2.6^{a}_{y}	0.1
SEM			0.1	0.1	0.1	0.2	

^{xyzw} separates storage condition effects; ^{abcde} separates duration effects. Means with the same superscripts (along same rows) and subscripts (along same columns) show no significant differences while those with different superscripts (along same rows) and subscripts (along same columns) are significantly different at (P< 0.05). SEM means Standard Error of the Mean.

Table 2
Proximate composition of open-dried quail eggs under different storage conditions

Storage condition	% Moisture	% Ether extract	% Ash	% Crude protein
Control (Room temperature)	10.4^{b}	20.9^{b}	2.0^{b}	28.5^{b}
Refrigeration	11.5^{b}	25.5^{ab}	2.7^{ab}	32.1^{a}
Oiling	13.2^{a}	29.9^{a}	3.2^{a}	32.9^{a}
Black polythene bag	12.9^{a}	28.4^{a}	2.9^{ab}	32.8^{a}
SEM	0.6	1.5	0.1	0.9

^{ab} separates storage condition effects along columns
Means in the same column with the same superscripts$^{(ab)}$ show no significant differences while those with different superscripts$^{(ab)}$ differ significantly at (P< 0.05).
SEM means Standard Error of the Mean.

Table 3
Proximate Composition of Open- dried quail eggs as affected by length of storage

Length of storage	%Moisture	%Ether extract	%Ash	%Crude protein
Day 0	15.5^{a}	32.0^{a}	3.4^{a}	35.3^{a}
Day 4	14.9^{ab}	27.1^{ab}	3.4^{a}	33.0^{ab}
Day 7	12.9^{b}	25.2^{bc}	2.6^{b}	30.5^{cb}
Day 21	4.7^{c}	20.3^{c}	1.8^{c}	27.4^{c}
SEM	0.6	1.5	0.1	0.9

^{abc} separates length of storage effects along columns
Means in the same column with the same superscripts$^{(abc)}$ show no significant differences while those with different superscripts$^{(abc)}$ differ significantly at (P< 0.05).
SEM means Standard Error of the Mean

refrigeration, oiling and black polythene bag methods is an indication of chemical degradation of the internal properties of egg as length of storage increases and favourable environment for bacterial actions. Haugh units are 75% and above for excellent quality eggs and 50% and below for stale eggs. The highest haugh unit (62.1) for this study was recorded when the egg was fresh, this is lower than the recommended value for the excellent quality eggs (4), however the highest haugh unit of 58.4 at the end of the length of storage (day 21) was recorded by refrigeration method. Eggs stored in the refrigerator have high yolk indices and haugh values. This was respectively followed by eggs coated with oil, black polythene bag and control. The lower values obtained for yolk indices and haugh units may be due to environmental temperature which has the greatest effect on egg quality. A reduced temperature as low as 12 °C (refrigeration) for maximum egg quality retention (5, 6). Decreased storage temperature reduces water movement from albumen to yolk resulting in good quality albumen (10). Researches have shown that storage of eggs at room temperature for one month resulted in yolk mottling (11,15). All storage temperatures in this study except refrigeration exceeded 18 °C thus conducive for metabolic activities that resulted in quality reduction. Storage under refrigeration has lowest storage temperature hence highest indices.

Yolk index and thick albumen decreased with length of storage. This was due to breakdown of the fibrous glycoprotein ovomucin. They also indicated that egg yolk size increased with storage time due to movement of water from the albumen to the yolk as a result of osmotic pressure differences (10). An interaction (P< 0.05) was found between storage time and length of storage for proximate composition of quail eggs. There was a gradual decrease in the values of the moisture, ether extract, ash and crude protein content of quail egg during storage. Storage methods affected the composition for the whole length of storage. Refrigeration and oiling had the highest values for moisture, ether extract, ash content and crude protein.

Conclusion

From this study, considering various quality parameters, quail eggs can be stored for 4 days at room temperature and still maintain desired internal quality parameters. Though the quality parameters were altered by storage length and can be maintained by proper storing. Quail eggs are best stored at low temperature without deteriorating. For storage of eggs up to seven days, refrigeration, oiling and black polythene bag methods could be used although the best storage condition is refrigeration but where it is not available, oiling can be used.

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