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EFFECT OF STORAGE METHOD AND TIME ON NUTRITIONAL PROPERTIES OF CHICKEN EGGS

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ABSTRACT

The study was conducted to determine the effect of storage period (0, 7, 14 and 21 days) and method: room temperature (control), black polythene bag (BPB), perforated black polythene bag (PBPB) and oiling (oil coated eggs) on proximate composition of commercial chicken eggs. The experiment was laid in a 4 x 4 factorial arrangement in Completely Randomized Design with 3 replicates. Significant effects of time and storage method on crude protein and ether extract ($P<0.05$) were observed. Oil coated eggs had higher values for both crude protein (24.37 %) and ether extract (15.49 %) and these parameters decreased ($P<0.05$) with increases in storage time. Significant interaction effect ($P<0.05$) of storage method and time was evident on crude protein and ether extract. Except at 21 days of storage, oiling was observed to have the highest values for both crude protein and ether extract in all the storage time. Thus, chicken eggs could be preserved by oiling since its nutritional value at any storage period is higher than the other methods of preservation. Therefore, oiling is recommended for egg preservation specifically in rural environments were electricity for refrigeration is not readily available.

Keywords: Chicken egg, Crude protein, Ether extract and Storage period

INTRODUCTION

Chicken is a domesticated fowls or birds kept and managed for food (meat and egg) and are the most popular species of poultry reared by man. Eggs obtained from chickens remain the major proteins source for human across the globe and have a biological value of 1.0 and rich in essential amino acids, thiamine, riboflavin, vitamins A and iron (Scott and Silver siders, 2001). They are also a good source of raw material for industrial uses. For example, fertile eggs are used in vaccine production, egg yolk and white serve as important raw material in the manufacture of shampoo and adhesive, respectively while egg shell is used as calcium source in feed and fertilizer. All food has limited shelf life which varies according to type and storage condition. Poultry egg deteriorates rapidly and was attributed to certain environmental condition such as temperature and relative humidity during preservation. These significantly affected the nutritional properties and modify certain characteristics such as H_2O and CO_2 content, and albumen pH (Ducuypere, 2001). Report showed that loss of water, microbial inversion and high temperature decrease quality and nutritional value of egg. Therefore, method like low temperature and modified atmosphere should be provided for retained quality and nutrient (Chang, 2000). The optimum storage temperature for poultry egg is 12^oC, while for fertile eggs; length of storage should not be more than 10 - 14 days (Stadelman, 2011). Refrigeration is necessary for successful commercial egg preservation (Ducuypere, 2001), but due to the poor supply of electricity in most Saharan and sub-Saharan African countries, this method of egg preservation is rarely accomplished specifically

in the rural environment. Therefore, the current finding seeks to investigate the effects of some locally available materials in the preservation of egg.

MATERIALS AND METHODS

Experimental Location

The study was conducted at Animal Science Laboratory of the Federal University Kashere, Gombe, Gombe State. The state lies between latitude 10^0 15' north and longitude 11^0 10' east. It is bordered with Borno, Bauchi, Yobe, Taraba, and Adamawa States and has an area of 20265km^2 with a population of around 2,365000. The State has two distinct climates; rainy season (from April to October) and dry season (from November to March) with an average annual rainfall of 850mm (National Geospatial intelligence Agency, 2012).

Experimental Material and Design

A total of forty eight eggs were used for the study, they were sourced from commercial chickens managed intensively at Federal University of Kashere Teaching and Research Farm. The experiment was laid in 4 by 4 factorial arrangement in a completely randomized design (CRD) with 3 replicates.

Experimental Procedure

The eggs were grouped into four treatments (12 each per treatment); Shell coating, Black polythene bag, perforated black polythene bag and room temperature and in each treatment, four storage periods (0, 7, 14 and 21 days) were examined. This is as shown below in Table 1.

Table 1: Experimental layout

	Storage method				
Duration (Days)	**RT**	**BPB**	**PBPB**	**Oiling**	**Total**
0	3	3	3	3	12
7	3	3	3	3	12
14	3	3	3	3	12
21	3	3	3	3	12
Total	**12**	**12**	**12**	**12**	**48**

RT = Room temperature, BPB = Black Polythene bag and PBPB = Perforated Black Polythene bag

Storage Methods

The four storage methods utilized include;

Room temperature (control)

In this method, eggs were placed on crate untreated and stored at room temperature

Black polythene bag

Here, eggs were stored in tied black polythene bag at room temperature.

***Perforated black polythene bag*:**

Eggs were stored in tied perforated black polythene bag

Oiling (shell coating)

For this method, eggs were coated or immersed into edible oil (ground nut oil) and allowed to drain for at least 1 minute which was later stored at room temperature on flat surface.

Proximate Analysis

After storage, sixteen eggs were randomly selected according to storage method and period for proximate analysis. Prior to the analysis, the selected eggs were deshelled and dried. The parameters recorded include; moisture content, crude protein (CP), ether extracts (EE) and ash.

Dry matter determination

The weight of the empty dish was recorded. Five grammes of powdered egg was placed in the dish and the weight of both dish and seed meal measured and recorded. The dish containing the sample was placed in an oven until a constant weight was achieved at 100^0C. The dish and content was placed in a desiccator to cool. The percentage moisture and dry matter were determined as follows:

$$\% \, moisture = \frac{W2-W3}{W2-W1} x \, 100$$

Where:

W_1 = Initial weight of empty dish

W_2 = Weight of dish plus sample before drying

W_3 = Final weight of dish plus sample after drying

% Percentage dry matter (DM) = 100 - % moisture content

Crude protein determination

The crude protein contents of the samples were determined using the Kjeldahl procedure as follows.

Digestion

Two grammes of powdered egg is weighed into a digestion flask and then digested by heating to temperature of 420^0C for three hours in the presence of sulfuric acid (an oxidizing agent which digests the food) and two tablets of Kjeldahl. Digestion converts any nitrogen in the food (other than that which is in the form of nitrates or nitrites) into ammonia, and other organic matter to CO_2 and H_2O. Ammonia gas is not liberated in an acid solution because the ammonia is in the form of the ammonium ion (NH_4^+) which binds to the sulfate ion (SO_4^{2-}) and thus remains in solution.

Protein (-N-) + H_2SO_4 → $(NH_4)_2SO_4$ + CO_2 + H_2O

After digestion is completed the sample is allowed to cool to room temperature, then diluted with water and transferred to the distillation unit.

Distillation

During the distillation step, the ammonium ions (NH^+_4) are converted into ammonia (NH_3) by adding alkali (NaOH).

$(NH_4)_2SO_4 + 2NaOH \rightarrow 2NH_3$ (gas) + Na_2SO_4 + $2H_2O$

Thirty millilitres of 4% boric acid plus bromocresol green and methyl red indicators were poured into a conical flask and placed underneath the distillation chamber for the collection of ammonia. The ammonia gas that is formed is liberated from the solution and moves out of the digestion flask and into the receiving flask - which contains an excess of boric acid. The low pH of the solution in the receiving flask converts the ammonia gas into the ammonium ion, and simultaneously converts the boric acid to the borate ion. The solution in the conical flask was observed until it changed from orange to green

NH_3 + H_3BO_3 (boric acid) → NH_4^+ + $H_2BO_3^-$ (borate ion)

Titration

About 0.1ml of normal HCl was added into a burette. The content of the conical flask was then titrated until the colour changed from green to pink. The burette reading was taken. A similar content of flask without distillate was also titrated and the reading taken. The percentage crude protein was computed using the relationship:

$$\% \, CP = \frac{(A-B) x \, N \, x \, F \, x \, 6.25}{Weight \, of \, sample}$$

Where:

A = volume of acid for the titration

B = volume of acid for titrating blank sample

N = normality of acid used for titration

F = factor 14.007

Note: Molarity and Normality concentrations are interchangeable.

Normality = valence x molarity

Molarity = normality/valence

Ether extract determination

The ether extract was determined using the Soxhlet apparatus. Two grammes of each sample was weighed into a thimble and mixed with 200ml petroleum ether in a conical flask. The solution was heated at 45^0C for 2 hours. The flask was removed, reweighed and percentage fat was determined using the relationship:

$$\% Fat = \frac{Weight\ of\ fat}{Weight\ of\ sample}\ x\ 100$$

Ash determination

The ash content of the seed meal was determined by weighing 5g of finely ground dry sample. The sample was charred on a Bunsen flame inside a fume cupboard, to drive off the smoke. The sample was transferred into a pre-heated muffle furnace at 550^0C until a white or light gray ash was obtained. Percentage ash was determined using the relationship:

$$\% Ash\ (dry\ basis) = \frac{Weight\ of\ ash}{Weight\ of\ original\ sample} x\ 100$$

Data Analysis

The data generated were subjected to analysis of variance (ANOVA) using SPSS version 23 (2015). Significantly different means were compared using least significant difference (LSD). The model utilized was as follows:

$\mathbf{Y}_{ij} = \mathbf{U} + \mathbf{M}_i + \mathbf{P}_j + (\mathbf{MP})_{ij} + \mathbf{e}_{ij}$

Where

$\mathbf{Y}_{ij}$ = Dependent variable

U = Overall mean

$\mathbf{M}_i$ = Effect of i^{th} method of preservation (1, 2, 3, 4)

$\mathbf{P}_j$ = Effect of j^{th} storage period (1, 2, 3, 4)

$(\mathbf{MP})_{ij}$ = Interaction effect of i^{th} method and j^{th} storage method

$\mathbf{e}_{ij}$ = residual error

RESULTS

The average proximate composition (crude protein, ether extract, moisture and ash) of egg according to storage method and period are presented in Tables 2 and 3. Significant effect of storage method and period on crude protein (CP) and ether extract (EE) ($P<0.05$) was observed. Oil coated egg had the highest for both CP (24.37 %) and EE (15.49 %) followed by those stored in black polythene bag (BPB) and perforated black polythene bag (PBPB), and at room temperature (RT). The result obtained in the present observation revealed that as days of storage increases, both the CP and EE decreased ($P<0.05$). The non-significant ($P>0.05$) influence of storage method and period on moisture and ash was however observed. Interaction effect of storage method x storage period on CP and EE are presented in Tables 4 and 5, there was significant ($P<0.05$) interaction effect. Within each of the storage method (RT, BPB, PBPB and Oiling), both CP and EE decrease significantly from day 0 of storage to 21. Except at day 7, CP did not vary significantly with storage method. While for EE, considerable effect of storage method was evident.

Table 2: Effect of storage method on nutritional properties (%) of chicken egg

Storage method	C P	E E	Moisture	Ash
Overall mean	21.83	13.25	7.69	3.90
R T (control)	19.38^{b}	11.81^{b}	7.53	3.83
B P B	23.31^{a}	13.21^{b}	7.89	3.98
P B P B	20.25^{b}	12.47^{b}	7.73	3.83
Oiling	24.37^{a}	15.49^{a}	7.62	3.94
SEM	0.873	0.739	0.241	0.074

^{abc} Means in the same column with different superscripts differ significantly (P<0.05).
SEM = Standard error of means, CP = Crude protein, EE=Ether extract, RT = Room temperature, BPB = Black polythene bag and PBPB = Perforated black polythene bag

Table 3: Effect of storage period on nutritional properties of chicken eggs

Storage period (Days)	C P	E E	Moisture	Ash
Overall mean	21.83	13.25	7.69	3.90
Day 0	25.02^{a}	15.12^{a}	7.80	3.92
Day 7	23.11^{a}	14.19^{a}	8.02	3.97
Day 14	21.12^{b}	13.15^{b}	7.22	3.83
Day 21	18.08^{c}	10.44^{c}	7.73	3.83
SEM	0.617	0.337	0.309	0.027

$^{abc:}$ Means in the same column with different super scripts differ significantly (P<0.05).
SEM = Standard error of means, CP = Crude protein and EE = Ether extract.

Table 4: Interaction effect of period and storage method on crude protein

Storage period	Storage method			
	R T (Control)	B P B	P B P B	Oiling
Day 0	$24.37^{\alpha a}$	$24.57^{\alpha a}$	$23.32^{\alpha a}$	$26.26^{\alpha a}$
Day 7	$20.25^{\beta b}$	$23.34^{\alpha a}$	$23.01^{\alpha a}$	$24.37^{\beta a}$
Day 14	$20.02^{\beta a}$	$21.44^{\beta a}$	$20.06^{\beta a}$	$22.78^{\beta\gamma a}$
Day 21	$18.55^{\gamma a}$	$18.22^{\gamma a}$	$18.42^{\gamma a}$	$18.09^{\gamma a}$
SEM	0.14	0.14	0.14	0.14

^{ab}Means with different superscripts along rows differ significantly (P<0.05).
$^{\alpha\beta\gamma}$Means with different superscripts along columns differ significantly (P<0.05).
RT = Room temperature, BPB = Black polythene bag and PBPB = Perforated black polythene bag.

Table 5: Interaction effect of period and storage method on ether extract of chicken eggs

	Storage method			
Storage period	**R T (Control)**	**B P B**	**P B P B**	**Oiling**
Day 0	$15.16^{\alpha b}$	$15.34^{\alpha b}$	$15.48^{\alpha ab}$	$15.55^{\alpha a}$
Day 7	$13.21^{\alpha\beta b}$	$13.28^{\alpha\beta b}$	$13.09^{\beta b}$	$13.64^{\beta a}$
Day 14	$12.47^{\beta a}$	$12.58^{\alpha\beta a}$	$12.23^{\beta ab}$	$12.96^{\beta\gamma a}$
Day 21	$11.90^{\beta a}$	$11.81^{\beta a}$	$11.51^{\gamma a}$	$11.06^{\gamma b}$
SEM	0.09	0.09	0.09	0.09

^{ab}Means with different superscripts along rows differ significantly (P<0.05).
$^{\alpha\beta\gamma}$Means with different superscripts along columns differ significantly (P<0.05).
RT = Room temperature, BPB = Black polythene bag and PBPB = Perforated black polythene bag.

DISCUSSION

The overall mean for percentage CP observed in the present study is similar to the value of 19.65 % recorded by Kabir *et al*. (2015) among commercial layer birds. However, Abdul Rehman *et al*. (2016), Chepkemoi *et al*. (2017) and Ominiyi and Abba (2018) reported lower means of 11.75±3.56, 15.40±1.65 and 12.40 % in White Leghorn, Lohman Brown and Rhode Ireland Red layers, respectively. The work Ahmad *et al*. (2017) on some selected breeds of water fowls (native duck, farm duck, Chinese goose and goose) also reported lower CP values of 13.32±0.31, 12.03±0.14, 12.08±0.37 and 13.86±0.57 %, respectively. The mean EE (13.00 %) observed in this study is lower than 15.10±0.06 and 36.18±0.04 % (Onyeweaku *et al*., 2018 and Bologa *et al*., 2013, respectively) in Lohman Brown layers, but higher than 11.40±0.64 % in the same breed of chicken (Radu-Rusu *et al*., 2014). Isaac and Chiedu (2016) reported lower values of 0.04±0.00, 0.07±1.12 and 0.02±0.10 % in guinea fowl, ducks and quail eggs, respectively. The average moisture percent observed in the present study is slightly similar to the value (6.74 %) reported by Ndife *et al*. (2010) in Lohman Brown layer eggs. However, lower means 4.90±0.17 and 5.74 % in Lohman and White Leghorn layers were recorded by Asghar and Abbas (2015) and Kudre *et al*. (2018), respectively. The average percentage ash (3.90 %) recorded in the present observation is similar to the value reported by Onyenweaku *et al*. (2018) in boiled local chickens' egg (3.80±0.07 %). Kudre *et al*. (2018) recorded average of 2.51±0.10 % in White Leghorn chicken which is closer to the estimated value observed obtained in this study. However, Kabir *et al*. (2015) and Chepkemoi *et al*. (2017) recorded lower means of 1.54 and 0.86±0.12 % in commercial layer eggs, respectively. Working on Nigerian indigenous layer, Fakai *et al*. (2015) also reported lower mean value of 1.33±0.58 % in Shika Brown eggs.

The effect of storage method on CP and EE observed in the present study corroborates the work of Dudusola (2009) who reported a significant variation in the proximate composition of quail egg preserved in black polythene back, using groundnut oil and under room and refrigerated (10^{o}C) temperatures. The author recommended refrigeration and oiling because both had higher values for all the parameters observed (moisture, ether extract, ash content and crude protein). He also noticed that egg quality characteristics such as yolk index and Haugh unit also varied with storage method. Eggs stored at refrigerated temperature had the highest for both variables (yolk index

and Haugh unit) followed by oil coated ones, those stored in black polythene bag and under room temperature (control). The author attributed the lower values obtained for room stored eggs and those preserved in black polythene bags to environmental temperature which has great influence on egg quality characteristics and emphasized that average temperature of 12^{o}C is required for optimum egg quality (Brake *et al*., 1997) because at this condition, water movement within the egg (from albumen to yolk) is restricted thereby resulting in good quality albumen (Haugh, 1937). The finding of Otles and Hisil (2001) showed that eggs preserved at room temperature (18 – 20^{o}C) for a period of one month developed mottled yolk due to high metabolic activities. This significantly reduces the egg quality characteristics.

Similarly, Raji *et al*. (2010) reported the effect of storage method on egg weight of commercial laying hen and recorded mean values of 50.59, 51.70 and 54.81g for room temperature, oiling and refrigeration, respectively which differed significantly from the fresh egg weight (58.36g) and attributed the lower weight change observed in refrigerated and oil coated eggs to less moisture loss during storage (ACIAR, 1988). The authors indicated that albumen and yolk height decreased significantly with increasing storage temperature and corroborated this fact to the work of some investigators (Scott and Silversides, 2000; Samli *et al.*, 2005) who showed that weight change in egg is positive correlated to storage temperature. Further explanation by these authors showed that the variation observed in characteristics of eggs preserved using different methods of storage is due to their varying ability to retard carbon dioxide loss and the breakdown of carbonic acid to this gas (carbon dioxide). In addition, earlier work of Mountney (1976) proved that eggs stored for a long period of time or under high temperature losses carbon-dioxide (CO_2) which causes the destruction of Mucin fibre that gives the albumen and yolk their gel-like texture. Feddern *et al*. (2017) reported a significant decrease in weight and Haugh unit of eggs stored at room temperature (9 % weight loss and 58.93, respectively) compared to those preserved in refrigerator (< 6 % weight loss and 62, respectively) and corroborate the latter result to the value reported by Stadelman (2011) that HU of 60 - 72 indicated eggs of high quality (grade A).

The fact that storage period had effect on proximate composition of egg agrees with the finding of Dudusola (2009) who reported a gradual decrease in the values of moisture, ether extract, ash and crude protein content of quail eggs from 0 to 21 days of preservation. Omoniyi and Abba (2018) reported significant effect of boiling period on proximate composition of Rhode Ireland Red and Japanese quail eggs. Average ether extract of 9.3±0.01 and 9.6±0.00 % at 10 - 15 min and 30 – 60 min of boiling, respectively were recorded in the former which is higher than the mean value obtained for the raw egg (9.1±0.01 %), while in the latter, percentage fat of 11.03±0.01 was observed which is significantly higher than the value obtained at 2, 5, 10, 15 and 90 min of boiling (10.07±0.03, 9.54±0.02, 8.36±0.01, 7.91±0.03 and 4.71±0.03 %, respectively). Similar trend was also observed in percentage crude protein. In addition, the authors reported 0.9 % nitrogen free extract (NFE) in raw eggs of Rhode Ireland chicken, this significantly decreased to 0.8±0.010, 0.6±0.003, 0.01±0.003 and 0.00 % at 10, 15, 30 and 120 minutes of boiling, respectively, while in quail, corresponding values of 6.55 ± 0.19, 19.75 ± 0.09, 18.51 ± 0.12 and 25.52 ± 0.16 % were observed.

Abdul Rehman *et al*. (2016) reported a significantly higher ether extract in Fayoumi chicken egg than White Leghorn and attributed this difference to heavier yolk and higher yolk: albumen ratio. It is a well-known fact that yolk weight is positive correlated with ether extract (Bell and Weaver, 2002). Working on different

species of poultry (normal feather chicken, ISA Brown layers, guinea fowl and quail), Kabir *et al*. (2015) obtained a significantly higher dry matter, crude protein and ether extract in ISA Brown layers eggs.

The significant interaction effect observed in the present study agrees with the work of Dudusola (2009) who reported that refrigerated and oil preserved eggs had higher Haugh unit at all the storage periods (0, 4, 7, 14 and 21 days) than those stored at room temperature and in black polythene bag.

CONCLUSION AND RECOMMENDATION

The study showed that storage method and time had significant effect on crude protein and ether extract and that Oil coated eggs had higher values for both parameters specifically at 7 and 14 days storage period. Therefore, oiling is recommended for egg preservation specifically in rural environments were electricity for refrigeration is not readily available.

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