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Influence of storage on external quality characteristics, proximate composition and organoleptic properties of chicken eggs

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Abstract

This study investigated the effect of storage methods on the external and organoleptic qualities of domestic fowl eggs. Four methods of non-conventional egg preservation (oiling, polythene bag, earthen pot, and salt solution) were used. Four groups of 20 eggs each, were randomly allocated to each of the storage methods and stored for 21 days. Data were subjected to analysis of variance (ANOVA). Results showed that, storage methods did not significantly affect ($P>0.05$) all the external quality characteristics of the eggs except egg shape index. Egg samples stored in salt solution had higher Shape Index (82.47%) followed by samples stored on control, polythene bag and earthen pot, with 79.67, 79.03 and 78.80%, respectively. Samples stored by oiling had the lower shape index of 74.93%. Results of proximate composition indicated that storage methods had a significant effect ($P<0.05$) on all proximate components studied. Moisture content was significantly higher ($P<0.05$) in treated samples than the control samples. However, the untreated samples were significantly higher in Ash, Nitrogen, protein and carbohydrates than the treated samples. Results for organoleptic characteristics shows that storage methods significantly affected ($P<0.05$) the ease of peel and aroma of the boiled eggs. The study concluded that eggs should be kept in earthen pots and salt solution to ensure the conservation of both physical, proximate and organoleptic properties.

Keywords: Chicken eggs, Storage methods, Proximate composition, External characteristics, Organoleptic properties

1. Introduction

Egg is very nutritious and contains all the essential amino acids and fats, with most of the minerals and vitamins found in the yolk. The egg physical properties are important in the design considerations for effective equipment necessary for utilization, transportation and processing [1]. It has been considered among the excellent sources of animal-based proteins of its high digestibility (98%), biological value (94%) and considerably rich in essential amino acids [2].

Due to readily digestible nature of eggs, they can provide a significant portion of the nutrients required by an individual for growth and maintenance of body tissues for the day. They are also utilized in many ways by food industries and the home cuisines [3]. Although they are easily available foods for all categories of people because of their versatility, people are recently very concerned about their nutritional and safety quality. The aesthetic quality of eggs would be gradually deteriorated when they are kept for long periods of time, which might make them unsuitable for consumption. This made scientists to give more emphasis on finding ways of maintaining the quality of eggs so that consumers can have the product in a safe and wholesome state. Hence, appropriate technologies suitable for their storage essential to retain quality and safety [4].

It has been reported that method of eggs storage can influence the rate at which physical and biochemical changes can occur within the egg, which could ultimately lead to the gradual reduction in egg's internal and external qualities thereby undermining its nutritional composition, acceptability and utilization for other purposes [5]. Eggs undergo gradual deterioration in quality very easily beginning at the time of laying where they come in contact with surfaces and become contaminated with biological agents. Similarly, the different storage methods accompanied with longer storage time practiced by farmers can increase the rate of loss in egg quality. Different ways of storing eggs have been reported under rural and urban conditions using both traditional and modern equipment [6]. Among the numerous methods of egg include storage in storage in basket/clay pot/carton/polythene bag at room temperature', oiling, refrigeration, room temperature, saltwater, dry salt technique, and lime water. Refrigeration is still reported to be the best (as long as power supply remains favourable) while oiling gives better results compared to eggs stored in open crates or

bowls at room temperature, also packaging in polythene bags may be somewhat similar to oiling [7].

It is evident that both internal and external quality characteristics of eggs deteriorate over time and cannot be stopped. However, the rate at which the deterioration occurs can be reduced by appropriate means [8]. These changes have been reported to be occurring due to biological and physico-chemical activities mainly due to proteolysis and contamination with bacteria into egg shell as a result of poor storage [9]. It is however known that, external quality characteristics of eggs such as egg cleanliness, colour, texture and shape, egg weight and shell quality are valued by consumers [10]. Hence, proper storage for eggs becomes necessary in order to maintain its quality and to derive maximum utilization of eggs [5].

Eggs have also been reported to contain high levels of vitamins and minerals apart of the protein which they are known for [11]. The sensory attributes (Organoleptic properties) of eggs are aroma, color, texture, and taste. Colour differences between regular and enriched eggs are considered as desirable feature [12]. Among the most important parameters that affect the level of consumer acceptance of eggs is their aroma. Flavour has also been known to be an important factor related to organoleptic properties. Flavour of food in the mouth is as a result of chemical interactions between food and taste receptors through complex processes [13].

In Nigeria, egg production is increasing. However, unfavorable storage conditions can cause serious quality deterioration in the eggs which in turn consequently leads to loss and waste of eggs. Egg quality which comprises both internal and external aspects is related to the shell, albumin and yolk [14]. Therefore, there is a pressing need to preserve eggs using different favorable storage methods to prevent or reduce post-harvest losses due to spoilage and wastage.

Since eggs are rapidly perishable products, there is need for more information on their storage. Careful preservation of edible eggs has become a matter of immediate concern as improperly handled eggs may contain high levels of *Salmonella* bacteria which apart from causing damages in embryonic development in fertile eggs, can also lead to food-borne infections [15]. Therefore, there is need to explore the applicability of the existing traditional storage methods to harness the conventional systems. This research will investigate the effect of some traditional egg storage methods on external and organoleptic properties of domestic fowl eggs.

2. Materials and methods

2.1 Experimental site

The experiment was conducted in the Animal Science laboratory at the Faculty of Agriculture, Kebbi State University of Science and Technology, Aliero.

Aliero is a Local Government Area in Kebbi State, Nigeria, located between approximately longitude and latitudes 11°03'S, 12°14N and 3°6'W and 4°27'E**,** respectively. It has a total area of 412km^2 and is bordered to the East by Tambuwal Local Government Area of Sokoto State, to the North West by Birnin Kebbi Local Government Area and to the South West by Jega Local Government Area [16].

2.2 Source of experimental materials

The eggs for the experiment were collected from Labana farm Aliero, Kebbi state. Earthen pot was purchased from a local market in Kebbi state. All experimental materials were taken to the laboratory where they were prepared for the experiment.

2.3 Treatments and experimental design

The study consisted of four methods of egg preservation (oiling, polythene bag, earthen pot, and salt water). Each method represented a treatment. The experiment was laid down in a completely randomized design (CRD). Each treatment contained 20 eggs each that were randomly allotted and served as replicates for each treatment.

2.4 Experimental procedure

A total of 80 eggs were used for the experiment. The eggs were divided into four groups of 20 eggs in each, and were randomly allotted to each of the experimental storage methods; polythene bag, saltwater, oiling and earthen pot. The eggs in all treatments were stored for 21 days under the same room temperature. After the storage period, three (3) eggs each were selected at random for determination of external quality characteristics, ten (10) eggs each were randomly selected for determination of organoleptic properties. Two (2) eggs each were randomly selected for proximate analysis. The procedures were carried out as described by *Kurtu et al.* [17] and Duressa *et al.* [18] with little modifications to suit the current research.

2.4.1 Oiling method

Vegetable oil (Oki oil brand) was used for the experiment. The eggs that were preserved under this method were individually dipped in the oil for 5 seconds and allowed to drain before placing in egg tray in a well-ventilated room with an average of 31.7°C.

2.4.2 Storage in earthen pot

Eggs were put in a wide-mouthed earthen pot at room temperature. The bottom of the base was filled with sand and earth of equal ratio to a height of 15cm while the side was then filled up to half of the of the pot. Thin layer of dry grasses was lined on top of the sand inside the pot to prevent eggs from absorbing excess moisture. The eggs were placed in the pot over the thin grass layer

immediately after collection. The eggs were then covered with a thin cotton cloth to facilitate adequate ventilation. Water was sprinkled on the sand inside the twice a day (morning and evening).

2.4.3 Storage in polythene bags

The eggs stored in polythene bags were washed, dried, and arranged into a black polythene bag, sealed and then kept under room temperature.

2.4.4 Salt-solution storage

Eggs were dipped into a solution of 4% w/w sodium chloride (NaCl) salt for five minutes and then removed from the salt solution and dried using a clean tissue paper. The eggs were then placed on a crate and kept at room temperature.

2.5 Measurement of egg external quality characteristics

The external quality characteristics measured were:

i. Egg Weight: After the storage period, the individual eggs were measured using a digital electric weighing balance and expressed in centimeters (cm).
ii. Egg Width: The egg width was measured with a Vanier caliper and values were presented in centimeters (cm).
iii. Egg Length: The length of the egg was measured with a Vanier caliper and the resulting values were expressed in centimeters (cm).
iv. Egg Shape Index: The values for egg shape index were calculated by the following formula:

$$SI = \frac{W}{L} \times 100$$

Where, SI is the shape index, W is the weight of the egg and L is the length of the egg

v. Shell Texture: Texture of the egg was determined by using fingers to rub the surface of the shell of the egg. The feel of its smoothness or roughness was considered as its texture.
vi. Shell Weight: Shell weight was measured after removing the contents using a digital electric weighing balance and expressed in grams (g).
vii. Shell Thickness: A zero calibrated micrometer screw gauge was used to measure egg shell thickness and the results expressed in micrometers (µm).
viii. Shell Colour: Shell color was taken by visual observation.

2.6 Determination of organoleptic properties

Determination of organoleptic properties was conducted subjectively using the quantitative descriptive analysis (QDA) based on the principle of a panelist's ability to verbalize their subjective perception of a product. The five-point Hedonic scale according to [19] was used to evaluate the colour, appearance, texture, ease of breaking, ease of peel and aroma of the product after each storage period using a panel of 10 judges. The verbal anchors used at each point along the hedonic scale with nine categories were as follows for each of the organoleptic parameters measured.

2.7 Determination of proximate composition

The sampled eggs were taken to the laboratory for the analysis of proximate composition. Moisture content, crude protein content, ether extract, ash content and total carbohydrates were determined using the procedures outlined by [20].

2.8 Data analysis

The data that were collected from the experiment were subjected to one way analysis of variance (ANOVA) using General linear model procedure of SPSS. Subclass means with significant variation were separated using Turkey's test at 5% confidence interval.

3. Results and discussion

3.1 External qualities of Chicken eggs according to storage methods

Values for the external characteristics of chicken eggs according to storage methods are presented in Table 3.1. The values indicated that storage methods did not significantly (P>0.05) influence all the observed parameters of egg external quality except egg shape index (SI), which was significantly affected (P<0.05). The egg samples stored in salt solution had significantly higher SI (82.47%) followed by samples stored on control treatment, polythene bag and earthen pot, with 79.67, 79.03 and 78.80%, respectively. Samples stored by oiling had the lower shape index of 74.93%.

Table 3.1: External quality characteristics of domestic fowl table eggs according storage methods

Storage method	**Parameter**					
	Egg Weight (g)	Egg Length (cm)	Egg Width (cm)	Egg Shape Index (%)	Shell Weight (g)	Shell Thickness (µ)
Control	56.50	5.73	4.56	79.67^{ab}	7.06	44.00
Oiling	64.03	5.86	4.40	74.93^{b}	7.30	48.33
Earthen pot	60.80	5.83	4.53	77.80^{ab}	8.00	45.00
Salt solution	60.96	5.63	4.43	82.47^{a}	8.03	42.00
Polythene bag	61.73	5.73	4.53	79.03^{ab}	7.80	47.33
SE	2.899	0.102	0.125	1.619	0.282	3.509

**ab = means bearing different superscripts along a column differ significantly (P<0.05)

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There was no significant difference between the storage methods on egg weight, shell weight and shell thickness. This agrees with the findings of [21]. However, the weight of the domestic fowl eggs used in the current study was 56.5-64.03g, which falls within the range of 50-60g for normal and large category weighing > 60g. Uniformity of eggs in tray was found to be an important quality characteristic corresponding to the grading system of the USDA, where lack of uniformity in size and colour is considered a major egg defect [22]. The chicken egg shape index is classified by long egg shape (SI < 72), normal eggs (SI = 72-76), and round eggs (SI >76). Egg shape index is relative to performance of the shape of an egg. Thus, higher egg index values signify that eggs are round, while lower shape index values indicate that eggs are longer in shape. Egg shape index in the current study ranged between 74.93 and 84.47%. This is an indication that the eggs under study fall between normal egg shape (SI = 72-76%) and round egg shape (SI= >76%) according to USDA [23].

3.2 Proximate Composition of Chicken Table Eggs According to Storage Methods

Table 3.2 shows the proximate composition of chicken table eggs according to storage methods. Result showed that storage methods had significant (P<0.05) effects on all the proximate components of the eggs measured. Moisture content was significantly higher (P<0.05) in treated samples than the control. However, the untreated samples were significantly higher in ash, nitrogen, protein and carbohydrates than the treated samples.

Table 3.2: Proximate composition of chicken table eggs according to storage methods

Storage method	Parameter (%)					
	Moisture	Ash	Lipid	Nitrogen	Protein	Carbohydrates
Control	76.167^{b}	3.833	6.667^{a}	1.467^{a}	26.243^{c}	4.183^{a}
Oiling	83.500^{a}	0.833	5.167^{b}	1.000^{b}	29.150^{a}	4.080^{a}
Earthen pot	84.833^{a}	1.000	4.833^{b}	1.187^{bc}	27.417^{bc}	1.912^{b}
Salt solution	82.000^{a}	2.667	6.167^{a}	1.260^{ab}	27.877^{ab}	1.457^{b}
Polythene bag	84.667^{a}	1.833	4.167^{b}	1.077^{bc}	26.713^{bc}	2.287^{b}
SE	1.285	0.943	0.307	0.075	0.461	0.442

**a, b, c = means bearing the same superscripts along columns do not differ significantly (P<0.05)

The moisture content ranged between 76.167-84.833%, with the treated samples having significantly higher levels than the control samples. This could imply that the storage methods helped to conserve more moisture in the eggs. Saidu *et al.* [21] also found significant difference among storage methods. Similarly, lipid content ranged between. Samples with the lowest moisture content were the highest in lipid content, i.e., 76.167 and 6.667%, respectively. It shows that there is an inverse relationship between moisture content and lipid content of eggs.

3.3 Organoleptic characteristics of chicken table eggs according to storage methods

Table 3.3 shows the organoleptic characteristics of chicken table eggs according to storage methods. Results showed that storage methods had significant effects (P<0.05) on ease of peel (EOP) and aroma of the boiled eggs. However, the other variables were not significantly influenced by storage methods. All methods were within acceptability values of 3.33-4.30 points for colour. Texture values were also within the acceptability values with a range score of 3.3-4.0. Similarly, ease of break's acceptability score ranged from 3.20-3.90. However, ease of peeling and aroma had non acceptability values at oiling method of storage, with 2.40 and 2.50 and ease of peel was not acceptable (2.9) for control treatment. The total score however indicated that all the methods scored the acceptable limits of 3.0. Samples stored in pots were ranked first (3.96) in organoleptic characteristics, followed by samples stored in salt solution and polythene bags scoring 3.68 each.

Table 3.3: Organoleptic characteristics of chicken table eggs according to storage methods

Storage method	Parameter (score)						
	Colour	Texture	Ease of break	Ease of peeling	Aroma	Total	Ranking

Control	4.10	3.80	3.40	2.90^{ab}	3.700^{a}	3.58	3rd
Oiling	4.30	3.30	3.20	2.40^{b}	2.50^{b}	3.14	4th
Earthen pot	4.10	4.00	3.90	3.60^{a}	4.20^{a}	3.96	1st
Salt solution	3.33	3.88	3.55	3.44^{ab}	4.22^{a}	3.68	2nd
Polythene bag	4.30	3.80	3.70	3.00^{ab}	3.60^{a}	3.68	2nd
SE	0.344	0.330	0.391	0.363	0.370		

**a, b, c = Means bearing different superscripts on the same column differ significantly (P<0.05)

The differences in appearance could be due to the reduction in the egg's internal quality over the storage period. Eggs in storage loose water and CO2 through their shell, increasing the pH of the albumen, resulting in decreased freshness [24, 25]. The ease of peel of the eggs was found to differ significantly among the storage methods. Samples stored in earthen pots scored significantly higher means (3.60) than other treatments. Saidu *et al.* [21] also reported that Earthen pot and Oiling storage methods had a slight increase in peel index compared to Room Temperature storage. These results shows that Earthen Pots methods were able to keep the quality of the eggs for a longer period compared to room temperature storage which lose (CO_2) rapidly and therefore peels easily after few days.

4. Conclusions

Only egg shape index was significantly affected by the storage methods employed. Also, there was higher retention of all proximate components in the treated samples than the control. Similarly, ease of peeling and aroma of the boiled eggs scored higher in treated samples than untreated samples. It is therefore recommended that eggs should be stored in earthen pots and salt solution to ensure conservation of both physical, proximate and organoleptic properties.

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