IJSAR
ISSN: 2504-9070

EFFECT OF STORAGE METHODS ON EGG QUALITY AND ORGANOLEPTIC PROPERTIES OF BROWN EGG TYPE OF DOMESTIC CHICKENS IN VOM, JOS SOUTH, L.G.A PLATEAU STATE

***[1]UMORU U., [1] DANIAL D. G., [1]OLANREWAJU O. D., [1]UGUISI U. M., [1]OLUWA D.E., [1]IYABODE J.D., [1]CHOJI C.D [2]GHIBI L. A., [2]MESEKO J. T [2]UGHELU A.M., [3]UTAJI I. I. [4]ALKASIM I.A.,**

[1]Department of Agricultural and Pest Management Technology, Federal College of Animal Health and Production Technology Vom, Plateau State
[2]Department of General Studies, Federal College of Animal Health and Production Technology Vom, Plateau State
[3]Department of Science Laboratory Technology, Federal College of Animal Health and Production Technology Vom, Plateau State
[4]Department of Animal Production Technology, Federal College of Animal Health and Production Technology Vom, Plateau State, Nigeria

Corresponding author: uu65648488@gmail.com Tel: +2347065648488

ABSTRACT

A total of 211 poultry eggs were used for this study to determine the effects of storage methods on egg quality and organoleptic properties of brown egg type of domestic layers. The different storage methods used were Refrigeration, Room Temperature, Oiling, Covering with Leaves and Earthen Pot storage. The results obtained showed that eggs that were oiled and those stored in earthen pot had shelf life of 24 and 27 days respectively, since they maintained the specified minimum Haugh Unit value for eggs reaching consumers, for those periods of time. Effects of egg quality were significantly ($P<0.05$) affected by the different storage methods and season. The findings revealed that there were observable trends that rapid deterioration of eggs occurred as storage time increased and that the quality was affected by the methods of storage. During the dry season, eggs that were stored at room temperature had a shelf life of 9Days and 18 Days. Oiling and refrigerator storage methods in this study proved to be the best local methods of storage as they extend the shelf life of eggs. It was observed that eggs from the ECWA Rural Development Limited Bukuru can be stored at room temperature for up to 14 days, however treating by oiling the shell would reduce evaporation of water and carbon dioxide from the pores thereby maintaining the acid-base balance and retaining high quality.

1.0 INTRODUCTION

1.1 Background of the study

Nigerian population is rapidly increasing every day and agriculture is the basic sector that produces food to meet up with the teeming demand of the population. Death rate on the other hand, in Nigeria is also on the high side due to improper dieting or malnutrition. A domestic bird such as chicken tends to produce eggs for man's consumption as food which is very high in protein contents and its nutritional value and palatability. The biological values of different sources of protein, egg holds the second highest value of protein with an estimate of 93.7% after the natural breast milk, which have 100% fresheners of eggs, is a major concern of consumers. The main criteria of fresheners are haugh units, weight loss and air cell size. It was the aim of the present study to predict the development of these criteria in response to the main influencing factors. Storage temperature, storage duration and her age, multiple regression was used to the response of the criteria to storage duration and temperature. There was a small but significant reduction of egg shell thickness in response to hen age. Air cell size, weight loss were significantly influenced by storage duration with storage temperature. Chicken eggs are of excellent nutritional value for human consumption and the only food at animal origin which can be stored for several weeks in their natural condition without losing specific characteristics. Mckee S.R, et al, (2000).

The ability of eggs to be stored for several weeks evolves through their functions as sources of nutrients for the developing embryo. The yolk and the albumen are enclosed by the egg shell which allows the exchange of carbon dioxide, oxygen and water through the pores. The egg shell has about 10,000 to 20,000 cone shape pores space with smaller diameter of the corner position. The egg is a complex entity having four main parts; these are shell, cell membrane, albumen and yolk, 9% chalazae and 0.75% shell membrane. The egg contents in clued egg shell, outer membrane, inner membrane chalazae, external albumen, middle albumen, vitelline membrane, nucleus powder, germinal disc (nucleus) and yellow yolk, white yolk, internal albumen. The vitamins and minerals of eggs are iron, vitamin at which help to maintain healthy skin and eye tissue, vitamin D for strengthening bone and teeth, vitamin E which is an antioxidant, vitamin B helps to protect against heart disease, folate, protein, selenium, lutein acid, zeaxanthin, choline. Less than 60% of the market eggs produced, however, qualify for the top grades, a fact that indicates there is room for much improvement in the production and preservation of egg quality through better breeding and farm holding conditions. The egg is a very perishable article of food. The income of the producer depends on the egg reaching the consumer with as much of its original quality as possible. The quality of the egg is never improved after it is laid. It is lowered very quickly by many factors of management and by being exposed to high temperatures and low humidity. Any farmer who produces a surplus of eggs that must enter the channels of trade should provide suitable farm storage holding conditions for preserving the original quality of the eggs. A farm egg-storage room or its equivalent should not be considered as an expense. It is a necessary piece of equipment, an investment that will pay dividends to the owner and to the industry. In producing and maintaining egg quality, three major problems are involved: breeding, feeding, and care of the eggs after they are produced.

1.2 Statement of the problem

Currently, poultry production is fast becoming intensive in Nigeria and has become dependable source of income for

many farmers, with increase in poultry production and harvest of poultry product, we are faced with the pressing needs to preserve poultry product. In this case, eggs to prevent or to reduce postharvest losses due to spoilage and wastage. Deterioration in egg quality is attributed to moisture loss and a decline interior egg quality during extended storage.

Factors associated with decline in quality as storage time, temperature humidity and handling *(Samiestal 2005).* Maintaining good egg quality from producer to consumer is one of the major problems facing those engage in marketing eggs. Proper attention to production distribution and point of sales phases are of vital important in maintaining egg quality. Eggs with and air cell and absorption of off-flavour and odours (FAO, 2003, Muhammed, 2011) intact shells are relatively free of bacteria, and this is because eggs shell and their membrane provide a barrier against bacterial, contamination occurs if the egg shell is broken, cracks or if there is excreta contamination of the shell.

1.3 Significance of the study

There is mass increasing in poultry production in Nigeria as a result of the steady and substantial income achieved from its production particularly in layers production as eggs are gotten almost every day under proper management. This increase in productivity heralds the pressing needs to effectively store and pressure poultry produce (particularly). Eggs as related to the study in hands of the producer as well as the consumer eggs spoiled at home due to improper storage leading to deterioration in egg quantity both physical and chemical *(Obi and Igbokwe 2011).* Observed changes include watering albumen, enlargement and flattening of egg yolk and air cell and absorption of off-flavor and odours *(FAO, 2003, Muhammed, 2011, Scotts and Silversides, 2000).* This aims in identifying suitable storage methods that will significantly reduce the rate of which biological and physiochemical changes occur within the eggs. Egg quantity is composed of characteristics of egg that affects its acceptability to consumer, such as cleanliness, shell quality freshness and size *(Song et al 2000).* The egg is a very perishable product which could lost its quality rapidly during the period between when it is laid and consume. Eggs provide a unique and balance sources of protein which contain all the amino acid in sufficient amounts and proportion in maintaining life and support growth even when use as sole source of food. Poor storage conditions can reduce egg grade within a few days, proper storage of egg is essential to preserve quality and cooking characteristics.

1.4 Limitation of the study

The research work is limited to ECWA Rural Development Limited Bukuru and Federal College of Animal Health and Production Technology, Vom, in Jos South Local Government Area of Plateau State, Nigeria.

1.5Aim and Objective

1.5.1Aim

To determine the effects of storage methods on egg quality and organoleptic properties of brown egg type of domestic layers

1.5.2 Objective

- ✓ To examine the effect of storage methods on egg proximate composition
- ✓ To examine the effect dry season on egg quality
- ✓ To examine the organoleptic properties of brown egg type of domestic layers before and after storage.

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The research was carried out at Federal College of Animal Health and Production Technology, Vom of Jos South Local Government Area of Plateau State located in Nigeria, middle belt, with an area of 26,899 square kilometre, 008^0 32^0 and 010^0 38^0 east. The altitude ranges from about 1,200 metres (3,900) to peak of 1,829 meters (6,001) above sea level. It has an average temperature of 19^0 c-20^0 c and a mean annual rainfall of 131.795cm-146cm with the highest rainfall recorded during the month of July and August (Blench *et al,* 2003). And ECWA Rural Development Limited Bukuru which is situated in Jos South, Plateau state, Nigeria, it's geographical coordinate are 9^0 48' 0" North, 8^0 52' 0" east and its elevation is 1,230m (4,040ft).

3.2Source of Eggs

Eggs were collected at ECWA Rural Development Limited Plateau State, in Jos South Local Government Area of Plateau State, Nigeria.

3.3.0 Experimental Treatments

The experimental treatments consisted of storing eggs, using various methods, during the two distinct seasons in Jos South, Plateau State in Nigeria. The methods were as follows: Refrigeration, Room temperature, Oiling, covering with mango leaves and earthen pot storage.

3.3.1 Refrigeration

Eggs were kept under refrigeration at a temperature of 40 ^{0}C. A stand by generator was provided in case of power failure in order to ensure a constant temperature during the experimental period.

3.3.2 Room Temperature

Room temperature storage entailed collecting eggs and storing them in paper pulp egg trays on top of a table in a well-ventilated room with an average temperature of 31.79 ^{0}C during the dry season.

3.3.3 Oiling Method

The eggs were dipped in soya bean oil and allowed to drain before placing in egg trays. Before the oil was used, it was boiled to prevent introduction of microorganisms then preserved in a well-ventilated room with an average temperature of 31.79 ^{0}C during the dry season.

3.3.4 Covered with Leaves

Fresh mango leaves were used to cover eggs in paper pulp trays placed on table topspin a well-ventilated room at an average temperature of 31.79 ^{0}C during the dry season. The leaves were changed every 3 days.

3.3.5 Storage in Earthen Pot

Eggs were kept in a wide-mouthed earthen pot that was placed in the centre of a plastic basin at room temperature. The bottom of the basin was filled with sand and earth of equal ratio to a height of 15cm while the side was then filled up to half the height of the pot. The inside of the pot was lined with a thin layer of grass to prevent the eggs being soaked in excess moisture. The eggs were placed in the pot as soon as they were collected and the top covered with a thin cotton cloth to facilitate the exchange of air. 4 litres of water was sprinkled on the sand and earth inside the basin surrounding the earthen pot 2 times a day (i.e. morning and evening).

3.4 Experiment 1: Effects of storage methods and duration of storage on egg

A total of 211 eggs were used for this experiment. On day 1, one egg was selected at random for determination of internal and external egg quality parameters. The remaining 210 eggs were divided into 5 groups of 42 eggs each, which were randomly allocated to one of the following storage methods: refrigeration, room temperature, oiling, covering with leaves, and earthen pot storage, of the 42 eggs in each of the storage methods.

3.5 Experiment 2: Determination of moisture by Gravimetric method

2 grams of sample were accurately weighed into an aluminium dish with a cover having a diameter of 50mm and a depth of about 40mm. The dish was shaking and the content were evenly distributed; the dish was placed in an oven with cover kept by the side at 105±2 ^{0}C and dried for 18 hours. The dish was transferred to the desiccators to cool. The moisture was weighed and calculated.

It was calculated using:

$$\text{Moisture (\%)} = \frac{\text{Loss in weight due to drying}}{\text{Weight of sample}} \times 100$$

$$= \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where W_1 = Weight of empty dish
W_2 = Weight of dish + sample before drying
W_3 = Weight of dish + dried sample

3.6 Experiment 3: Determination of crude protein by Kjeldahl method

Digestion

1 gram of sample was weighed and recorded to the nearest 0.1mg and it was transferred to digestion tube, each of the tube used was without sample as blank as test. 2 Kjeldahl tablets and 20 ml of sulphuric acid was added, few drops of anti-foaming agent was added in case of foaming. The tube was placed in a digestion unit connected to the fume removal manifold. The sample was digested for about 1hour at 420± 20 ^{0}C. The digestion was turn off, the tube was removed and allowed to cooled for 10-20 minutes. Distilled water was added to each tube to a total volume of 80ml.

Distillation and Titration

A conical flask containing 25-30ml of concentrated boric acid was placed under the outlet of the condenser of the distillation unit, in such a way that the delivery tube was below the surface of the boric acid solution. 50ml of NaOH was added and distilled the ammonium by titrating the content of the conical flask with hydrochloric acid standard solution, a few droplets of indicator solution. The amount of titrant used was read; the endpoint reached the first traced of pink colour in the contents. The amount of acid used was recorded to the nearest 0.05ml for the blank test (vb) and for each sample (vs).

Percentage Nitrogen (%)

$$\%\ N = \frac{(Vs - Vb) \times M(HCL) \times 1 \times 14.007}{(W \times 10)}$$

Where,

Vs = ml HCL needed to titrate sample
Vb = ml HCL needed for the blank test
M(HCL) = morality of HCl
1 = the acid factor
14.007 = molecular weight of N
10 = conversion from mg/g to % and

W = weight of the sample (g)

Calculation percent Crude Protein (% CP):

$$\% CP = \% N \times F$$

Where,

F= 6.25 for all forages, feeds and mixed feeds
F= 5.70 for wheat grains and
F= 6.38 for milk and milk products

3.7 Experiment 4: Determination of crude fibre by Filtration method

Pre-treatment

1 gram of sample was weighed to the nearest of 0.1mg (W_1) to each of P100-crucible, the crucible was placed in the filtration equipment and 30ml of petroleum ether was added to each of the crucible and was filter using vacuum. The washing was repeated twice; the residue dried in air and was transferred to quantitatively to a beaker.

Digestion

150ml of sulphuric acid was added to each beaker and it was boiled for 30± 1minutes. Few drops of anti-foaming agent were added in case of foaming. The mixture was filter through the crucible using a vacuum, the residue was washed five times; each time with 10ml of hot distilled water. A volume of acetone was added to cover the residue; the acetone was removed after few minutes by applying slight suction. The residue was transferred quantitatively to the beaker. 150ml of potassium hydroxide was added to each beaker and was boiled for 30± 1 minute. The mixture was filtered through the crucible using vacuum. The residue was washed three times under vacuum, each with 30ml of acetone and it was dried by the suction after each washing.

Drying and Incineration

The crucibles were put in an oven which was adjusted to 103± 2 ^{0}C and was dried for 4hours. The crucibles were placed on desiccators and was allowed to cool, the crucible was weighed directly after it was removed from the desiccators to the nearest 0.1mg (W_2). Crucible was placed in muffled furnace and the samples were incinerated for 2hours at 550± 20^{0}C. The crucibles were placed in a desiccator and it was allowed to cool. The crucible was weighed directly after it has been removed from the desiccators to the nearest 0.1mg (W_3). It was calculated as:

Percent Crude fibre (% CF):

$$\% CF = \frac{(W_2 - W_3)}{W_1} \times 100$$

Where,

W_1 = weight of the sample
W_2= weight of crucible and residue after drying (g) and
W_3 = weight crucible and residue after incineration (g)

3.8Experiment 5: Determination of total ash by incineration method

A crucible was ignited in a muffle furnace for 1minute and was transferred to the desiccators to cool and weigh. 2grams of sample was accurately weighed into the porcelain crucible. The crucible was placed in a temperature-controlled furnace preheated to 600 ^{0}C held for 2hours. The crucible was transferred directly to the desiccators to cool and was weigh

immediately. The crude ash express as (%) by weight of the test sample is given as:

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

$$= \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where,

W_1 = Weight in grams of empty dish

W_2 = Weight in grams of dish + test sample

W_3 = Weight in grams of dish + crude ash

Proportion of test sample burnt is the organic matter.

Organic matter (%) = 100 – (% ash)

3.9 Experiment 6: Determination of Calcium by Spectrophotometric method

1 gram of sample was weighed to the nearest 0.2mg into a beaker and was placed to cool muffle furnace. The furnace was closed and the temperature was gradually raised to 550 ^{0}C over about 90 minutes. The temperature was maintained for 16 hours to remove carbonaceous material and the furnace was then open to cool. 10ml of hydrochloric acid was added to each of the beaker and was placed on preheated hot plate, the beakers were covered with glass plate and was digested for 20 minutes. The beaker was allowed to cool, and was removed from the hot plate. The content of the beakers was transferred quantitatively to 25ml volumetric flask, make up to the mark with distilled water and was mixed well. The calcium content in the measured solution was calculated by linear regression. Percent of calcium is calculated as:

$$\% \text{ Calcium} = \frac{(C \times V \times DF)}{(W \times 10)}$$

Where,

C = concentration calcium in measure solution (mg/litre)

V = volume of solution (in litres, i.e 0.025ltr)

DF = dilution factor (normally, i.e 1)

W = weight of the sample (g) and

10 = factor to convert g/kg to %

3.11 Organoleptic properties evaluation

Ten adult untrained panellists were selected by invitation and willingness to consume eggs by signing informed content performer. All the participants declared no allergy to eggs and egg products. It was a double-blinded study however, they were given a preliminary training and protocol was explained before the actual testing session. For each sensory characteristic participants were instructed to score the intensity of evaluation on a 20 points hedonic scale developed for this purpose (0-5=not intense, 6 -10=slightly intense, 11-15 =moderately intense, and 16-20= largely intense). Descriptions of different sensory attributes are presented in Table 3 and 4. Egg samples were prepared as described earlier by Hayat *et al*. (2010b). “Briefly, three eggs, per treatment or control sample, were boiled in a stainless-steel pot which contained ~900 ml of ambient tap water. After boiling, the water was drained from the pot and the strained eggs were cooled under running tap water.

The eggs were peeled and then cut into quarters (length-wise) for delivery to sample plates. For the treated sample, one egg from that treatment was quartered and then ¼ egg was delivered to a 6-inch, white paper board plate identified with a 3-digit blind code. For the control and blind control, care was taken so that each panellist received a "control" sample and a "blind control" sample from the same egg."

4.0 Result

4.1 Effect of storage methods on egg nutritional value

Table 1: Proximate composition of egg before storage

SAMPLE	MOISTURE	CRUDE PROTEIN	CRUDE FIBRE	LIPIDS	ASH	NFE	CALCIUM	PHOSPHORUS
Egg	75.86	14.89	2.80	5.88	0.50	0.07	0.25	0.04

Table2: Proximate composition of egg after storage

SAMPLE	MOISTURE	CRUDE PROTEIN	CRUDE FIBRE	LIPIDS	ASH	NFE	CALCIUM	PHOSPHORUS
Oil method	76.60	12.90	4.05	5.45	0.99	0.01	1.10	0.05
Earthen pot	75.22	13.59	2.23	7.17	0.85	0.94	1.02	0.01
Cover with leaves	75.34	14.06	2.78	6.34	1.05	0.43	1.07	0.01
Room temperature	71.74	13.40	2.98	9.39	1.00	1.49	1.05	0.02
Refrigerator	74.14	11.08	1.76	8.59	0.95	3.48	1.00	0.01

4.2Effect of egg storage under different methods on dry season

The changes observed in albumen height and Haugh unit during the dry season especially for room temperature storage and eggs covered with leaves is due to carbon dioxide lost through the shell, which makes the contents of the egg to become more alkaline, causing the albumin to become transparent and increasingly watery (Okeudo*et al*., 2003). At higher temperatures, loss of carbon dioxide is faster and the albumin quality deteriorates faster. Decreasing temperatures in the hotter months during storage will help to reduce deterioration of the albumen. Eggs stored at ambient temperatures and humidity lower than 70% will lose 10-15 HU in a few days from point of lay. By 35 days, these eggs will lose up to 30 HU (Natalie, 2009). Storage of

eggs at temperatures of 7-13°C and a humidity of 50-60% will reduce the rate of degeneration of thick albumen proteins and, consequently, egg albumin quality will be maintained for longer (Jones, 2006). Oiling of eggs can also help to reduce carbon dioxide losses and thus help maintain internal egg quality (Okoli and Udedibie, 2000, 2001; Okeudo*et al*., 2003) but is not a substitute for cool storage.

4.3 Organoleptic properties of brown egg type of domestic fowl before and after storage

Table 3: Organoleptic properties before storage

Samples	Color	Aroma	Texture	Flavor	Head entrails
Oil method	5	3.3	5.2	3.6	4.7
Earthen pot	10	5.3	3.9	5.8	4.6
Cover with leaves	15	4.8	5.2	4.9	5.1
Room temperature	18	5.2	4.8	4.8	5.2
Refrigerator	20	4.9	5.6	5.4	5.2

Table 4: Organoleptic properties after storage

Samples	Colour	Aroma	Texture	Flavour	Head entrails
Oil method	0	4.3	4.6	5.2	5.3
Earthen pot	5	4.7	4.9	5.3	5.1
Cover with leaves	10	5.1	5.4	5.8	5.5
Room temperature	15	4.9	5.0	5.6	5.4
Refrigerator	20	4.8	4.4	5.6	4.9

5.0 DISCUSSION

This study was carried out to investigate the effects of storage methods on egg quality and organoleptic properties of brown egg type of domestic fowl. The albumen and yolk PH increased significantly with storage time.

Akyurek and Okur (2009) also observed significant increases in PH of albumen and yolk with increased storage time. They noted that the vitilline membrane tend to deteriorate with storage time, thus, allowing nutrients in the yolk to become available to any microorganisms present in the albumen, thereby enhancing degradation process in the egg. The present findings, generally, affirm the reports of Tilki and Anal (2004) and Singh *et al* (2011) that egg quality is at maximum when eggs are laid and their values decreases with increasing storage time.

Eggs start losing water through its membrane and shell pores to the environment from the time it is laid. Water loss depends on the temperature, airflow and relative humidity during storage. The longer the storage time, the more critical these factors become especially under room temperature and cover with leaves. As eggs gets older, the dense albumen becomes liquid due to numerous chemical reactions occurring therein, possibly involving carbonic acid formation and increased albumen PH. Carbonic acid, one of the components of albumen buffer -system dissociates to form water and carbon dioxide. Under natural conditions, carbon dioxide contained therein diffuses through the shell pores and evaporates, decreasing albumen acidity, increasing PH and chemical cleavage of the protein complex. The thickness loss dense albumen would be associated with the natural dissociation of this complex (Oliveira; Oliveira, 2013). As water and carbon dioxide escape from the egg shell, the PH of the albumen increases also as the egg gets older, the yolk absorbs water from the egg white and increases its size, this result in an enlargement and weakness of the viteline membrane; the yolk looks flat and shows spots. Once the egg is laid, its internal quality begins to decrease, the longer the storage time, the more the internal quality deteriorates the chemical composition of the egg does not change much, however.

5.1 CONCLUSION

This study was undertaken with the aim of investigating the effects of storage methods on egg quality and organoleptic properties of brown egg type of domestic fowl. The findings revealed that there were observable trends that rapid deterioration of eggs occurred as storage time increased and that the quality was affected by the methods of storage. It was observed that eggs from the ECWA Rural Development Limited Bukuru can be stored at room temperature for up to 14 days as a quality, however treating by oiling the shell would reduce evaporation of water and CO2 from the pores thereby aid in maintaining the acid-base balance and retaining high quality.Eggs that were oiled and those stored in earthen pot had shelf life of 24 and 27 daysrespectively, since they maintained the specified minimumHaugh unit value of 60, for eggs reaching consumers, for those periods of time. During the dry season, the shelf life was 21 days for both oiled eggs and those stored in earthen pot.During the dry season, eggs that were stored at room temperature had a shelf life of 18 days and 9 days. Oiling and earthen pot storage methods in this study provedto be the best local methods of storage as they extended the shelf life of eggs.

5.2 RECOMMENDATIONS

It is recommended to poultry farmers to employ the oiling and earthen pot storage as analternative, to refrigeration, for preserving their eggs. Food outlets that serve boiled eggs should store eggs on the date of purchase so that older onesare used for boiling and fresh ones for frying.Further studies should be carried out on the economic analysis and acceptance of oiling andearthen pot storage.

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