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# Effects of spraying chicken eggs with groundnut seed oil and different storage period on the quality and nutritional value

**Ayalew, F.[1*], Negasi, A.[2], Mitiku, E.[2] Addisu, A.[1] and Desalegn, W.[1]**

[1]Debre Markos University, College of Agriculture and Natural Resource, PO Box 269, Debre Markos, Ethiopia; [2]Haramaya University, School of Animal and Range Science, PO Box 138, Dire Dawa, Ethiopia.

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**Abstract** The egg quality measurements were undertaken as egg weight loss (%), shell thickness, Haugh unit, yolk height, yolk width, yolk index and albumen height. The non-sprayed chicken eggs showed a higher weight loss percentage of 3.07% within 15 days of storage. However, it was shown to be lower the weight loss of 0.48% when sprayed. Even though a progressive decrease in yolk height, albumen height, yolk index and Haugh unit values were shown as the storage period advances, sprayed eggs which resulted to be greater within each storage period than non-sprayed eggs. Non- sprayed eggs stored for 15, 10, 5, and 0 day had a Haugh unit value of 52.42±2.66, 73.29±6.44, 77.51±3.88 and 85.72 ± 2.85, respectively. Whereas, Haugh unit values were shown as 82.43±4.31, 82.90 ±4.43, 84.73 ±3.25 and 85.52±6.37 respectively which recorded after spraying. There were significant differences ($P < 0.05$) in moisture percentage, fat and protein content among non-sprayed eggs kept for different storage period. But percentage of ash and carbohydrate were unaffected. There was gradually decreased in the percentage of moisture, fat and protein content as the storage period advances.

**Keywords:** Haugh unit, Albumen height, Fat, Protein, Ash, Carbohydrate

## Introduction

Stadelman (1977) has defined Egg quality as, the characteristics that affect its acceptability to the consumer's. For many years, the most important internal and external egg quality traits showed as, albumen weight, albumen height, yolk colour, egg weight, egg shape, shell thickness, breaking strength, specific gravity and air cell size (Sparks, 2006).

Eggs are the main sources of various nutrients such as lipids, vitamins, proteins and minerals. All essential amino acids are found in egg proteins, and it is used as standard for measuring the nutritional quality of other food products (FAO, 2003). In addition to the obvious nutritional quality of the egg, internal egg quality is extremely important concern. Several problems are encountered

* **Corresponding Author**: Ayalew, F.; **Email:** ayalew_fekadie@dmu.edu.et

during storage of eggs, including weight loss, interior quality deterioration, and microbial contamination. The movement of carbon dioxide and moisture through the shell governs changes in albumen and yolk and weight loss of eggs (Stadelman, 1986). In some developing regions of the world where refrigeration of eggs is seldom practiced, coating materials are effective methods to preserve the internal quality of eggs and prevent microbial contamination. Numerous food-grade coating materials have been proven to be efficient in reducing interior quality deterioration of eggs. These materials include chitosan, whey protein, waxes, mineral and vegetable oils (Jirangrat *et al*., 2010). Oil treatment of eggs reported to reduce $CO_2$ losses and maintained internal egg quality (Beyer, 2005; Coutts and Wilson, 1990), but is not a substitute for cool storage (Jacob *et al.,* 2000). The application of coatings on eggs reduces weight loss and maintains their internal measurement such as albumen and yolk height and sensory evaluation for eggs (Bhale *et al*., 2003). Film and coating can act as barriers against moisture, gas, and aroma transfer (Wan *et al*., 2005).

Ground nut seed oil is a vegetable oil which contains a small proportion of non-glyceride constituents. It has complex fatty acid composition including saturated fatty acids covering a wide range of its molecular weight. Groundnut seed oil is excellent food oil, having good flavor and high quality with its low free fatty acid value (Belcher, 2008). Fisseha (2009) reported that 95% of local chicken owners in the study district (Burie, found in west Gojjam zone of Ethiopia) stored eggs until the hen finished laying and started broodiness. The objectives of investigation were to evaluate the quality of chicken eggs sprayed by groundnut seed oil and stored for different storage duration, nutrient composition of eggs sprayed by groundnut seed oil and stored for different storage duration, and the interaction effect of oil spraying and storage duration on quality and nutrient composition of chicken eggs.

## Materials and methods

### *Study site*

The experiment was undertaken at Haramaya University poultry farm which was located at a longitude of 42$^o$ 3` E and latitude of 90$^o$ 26`N. it is also located at an altitude of 1980 above sea level and 515 km east of Addis Ababa. The maximum and minimum average temperature of the area was 24 and 8$^o$C, respectively and it has a mean annual rainfall of 780 mm (AUA, 1998).

### *Experimental material*

Groundnut seed oil was purchased from Hamaresa oil processing industry which is located near to Harar city and east of Haramaya University. The oil was sprayed over the eggs to reduce the number of egg pores. A total of 96 medium sized chicken eggs (72 for quality & 24 for nutritive value measurement) laid by 11-month-old WLH chicken layer of the same batch kept under a uniform storage condition at Haramaya University poultry farm were used.

***Experimental design and treatments***

A 2x4 factorial in a completely randomized design which has 2 factors (oil spraying and storage duration) with 3 replications was implemented. The treatment combinations were:

**Table 1.** Number of eggs used during the experiment for each replication

| Treatments combinations | Number of eggs used For the experiment |
|---|---|
| $T_1$= Sprayed & 0 day storage | 12 |
| $T_2$= Sprayed & 5 days storage | 12 |
| $T_3$= Sprayed & 10 days storage | 12 |
| $T_4$= Sprayed & 15 days storage | 12 |
| $T_5$ =Non- sprayed & 0 day storage | 12 |
| $T_6$ =Non- sprayed & 5 days storage | 12 |
| $T_7$=Non- sprayed & 10 days storage | 12 |
| $T_8$=Non- sprayed & 15 days storage | 12 |

Eggs were weighed and sprayed with groundnut seed oil and set in the egg tray in small end down position (Kim *et al.*, 2009). Each egg was weighed before and after storage for each replication using digital balance to determine the percentage of weight loss. Weight loss (%) of the sprayed eggs during storage was calculated as:

$$\text{Weight loss (\%)of sprayed} = \frac{Initial\ \ wt\ (g)after\ sprayed\ at\ day\ 0 - wt\ (g)after\ storage}{Initial\ wt\ (g)after\ sprayed\ at\ day\ 0}\ x\ 100$$

***Internal egg quality parameters***

The randomly taken eggs from each replicate were individually weighed and marked. The eggs were broken out on smooth flat mirror and the thick albumin height of each egg was measured with a tripod micrometer. Haugh unit was calculated according to Monira *et al.* (2003) by the following formula:
$HU = 100 \log (H - 1.7W^{0.37} + 7.6)$, where: - HU = Haugh unit, H = Height of albumin in millimetre and W = Egg weight in grams.

After eggs were broken out on a flat mirror, the yolk height was measured with tripod micrometer and yolk width using vernier caliper. Yolk index is expressed as the spherical nature of egg yolk by measuring the yolk height (Stadelman, 1986). The yolk index was calculated as yolk height ∕ yolk width (Stadelman, 1995). According to Obanu and Mpieri (1984), a progressive weakening of the vitelline membranes and liquefaction of the yolk is caused mainly by diffusion of water from the yolk height.

Shell thickness was measured with guage by taking from the broad end side (blunt region), middle side (equatorial region) and from the narrow side (sharp region) of eggs. Average shell thickness was finally calculated as the average of these three measurements.

A total of twenty-four (24) whole eggs (yolks and albumen together) were homogenized to make composite samples from each storage period. The homogenized samples were transferred to medium sized crucibles and stored in a cold room (4℃) and used for chemical analysis. The whole egg moisture, protein, lipid and carbohydrates contents were undertaken according to AOAC (1980). Moisture content was determined by drying egg samples in oven at 105℃ for 12 hr. By burning samples with muffle furnace oven at 600℃ for 6hr, ash was analyzed. Protein was determined by the method of semi-microkjeldah determination of N % and the values obtained multiplied with 6.25 to calculate the percentage of protein. Lipid/crude fat was analyzed by Soxhlet extraction. Lastly, carbohydrate was determined by subtracting ash, lipid, protein and moisture percentages from 100.

### *Data analysis*

The data collected during the period of the experiment was subjected to analysis of variance using SAS (2008) version 9.1.3 computer software. When the analyses of variance indicate the presence of significant difference between treatments means, then Tukey test was used to locate the treatment means that are significantly different.

The following model was used for the study.

$$y_{ijk} = \mu + Ai + Bj + (AB)ij + \varepsilon ijk \qquad i = 1, 2, 3, 4; j = 1,2; k = 1,\ldots,n$$

Where: A= storage duration, B= Oil spraying, $y_{ijk}$ = observation k in level i of storage duration and level j of oil spraying, $\mu$ = the overall mean, $A_i$ = the effect of level i of storage duration, Bj = the effect of level j of spraying, (AB)ij = the effect of the interaction of level i of storage duration with level j of oil spraying and εijk = random error.

## Results

### *Effect of oil spraying and storage on quality of chicken eggs*

The effect of spraying groundnut seed oil and storage duration (0/fresh, 5, 10 and 15 days) on weight loss percentage of medium sized WLH eggs is presented. There was a highly significant difference (P<0.05) in weight loss among all treatments. Weight loss percentage was influenced by the interaction effect of storage duration and oil spraying. Higher weight loss percentage (3.07%) was observed in eggs that are not sprayed with groundnut seed oil and stored for 15 days. But a mean weight loss percentage of only 0.48% was observed when eggs are sprayed with groundnut seed oil. Non- sprayed chicken eggs stored for ten days showed a lower weight loss percentage (1.72%) than the non-sprayed eggs stored for 15 days. but it was slightly higher than the sprayed chicken eggs stored for 15 days. Weight loss of non-sprayed eggs stored for 5 days decreased from 0.72% to 0.1% when they are sprayed. A lower weight loss percentage was observed on sprayed eggs stored for 15 days (0.48%) than non-sprayed eggs stored for 10 days.

### *Internal quality of chicken eggs*

A highly significant difference (P<0.05) among all treatments was recorded after investigating the effect of spraying groundnut seed oil and storage duration (0/fresh, 5, 10 and 15 days) on albumen height of medium sized WLH eggs. Non- sprayed eggs stored 10 days was observed to be greater in albumen height than non-sprayed eggs stored for 15 days. No significant difference in albumen height was observed between sprayed eggs stored for 15 and 10 days. Non- sprayed eggs stored for 15 days showed a lower height than any of eggs stored.

There was a highly significant differences (P<0.05) among all treatments in Haugh unit, which is an indicator of egg quality. Storage durations, oil spraying and their interactions had significantly affected (P<0.05) the mean of Haugh unit values of eggs. There was a significant difference in Haugh unit between non-sprayed eggs stored for 10 and 15 days (Table 2). Eggs stored for 10 days showed relatively a greater Haugh unit when they are sprayed. Similarly, sprayed eggs kept for 5 days had a greater Haugh unit value than non-sprayed eggs having the same storage period. Greater Haugh unit value was observed in sprayed than non-sprayed eggs in all storage periods.

**Table 2.** Effect of storage duration, oil spraying and their interaction on egg quality parameters

| Parameters | Effect of storage duration | | | | Effect of oil spraying | |
|---|---|---|---|---|---|---|
| | 0 day | 5days | 10 days | 15 days | Non-sprayed | Sprayed |
| **Weight loss (%)** | $0.00^{d} \pm 0.00$ | $0.72^{c} \pm 0.18$ | $1.72^{b} \pm 0.58$ | $3.07^{a} \pm 0.30$ | $1.38^{a} \pm 1.21$ | $0.23^{b} \pm 0.20$ |
| **Albumen height(mm)** | $6.98^{a} \pm 0.48$ | $5.74^{b} \pm 0.52$ | $5.19^{b} \pm 0.74$ | $3.04^{c} \pm 0.21$ | $5.24^{b} \pm 1.53$ | $6.57^{a} \pm 0.88$ |
| **Haugh unit** | $85.72^{a} \pm 2.85$ | $77.5^{b} \pm 3.88$ | $73.29^{b} \pm 6.44$ | $52.45^{c} \pm 2.66$ | $72.24^{b} \pm 13.09$ | $82.9^{a} \pm 5.63$ |
| **Yolk height (mm)** | $15.70^{a} \pm 0.66$ | $14.7^{b} \pm 0.82$ | $14.29^{bc} \pm 0.70$ | $13.66^{c} \pm 0.89$ | $14.59^{b} \pm 1.05$ | $15.16^{a} \pm 0.82$ |
| Yolk width (mm) | 39.56 ± 0.73 | 39.11 ±2.03 | 38.78 ± 2.05 | 39.11 ± 1.27 | 39.14 ±1.57 | 39.28 ± 2.61 |
| Yolk index | $0.40^{a} \pm 0.014$ | $0.38^{ab} \pm 0.03$ | $0.37^{ab} \pm 0.03$ | $0.35^{b} \pm 0.03$ | 0.37 ± 0.03 | 0.39 ± 0.03 |
| **shell thickness (mm)** | 0.32±0.02 | 0.32 ± 0.04 | 0.32 ± 0.04 | 0.33 ± 0.04 | 0.32 ±0.03 | 0.34 ± 0.03 |

| **Interaction effect (STR * SPR)** | Egg quality parameters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wt loss % | Albumen ht (mm) | Haugh unit | Yolk $H_t$ (mm) | Yolk Wd (mm) | Yolk Index | $SHT_{ave}$ (mm) |
| 15 X NS | $3.07^{a} \pm 0.30$ | $3.04^{e} \pm 0.21$ | $52.45^{e} \pm 2.66$ | $13.66^{d} \pm 0.89$ | 39.11 ± 1.27 | $0.35^{b} \pm 0.03$ | 0.33 ± 0.04 |
| 15 X S | $0.48^{cd} \pm 0.10$ | $5.91^{bcd} \pm 0.84$ | $78.52^{bcd} \pm 5.86$ | $14.90^{a} \pm 0.42$ | 39.44 ± 2.65 | $0.38^{ab} \pm 0.02$ | 0.34 ± 0.01 |
| 10 X NS | $1.72^{b} \pm 0.58$ | $5.19^{d} \pm 0.74$ | $73.29^{d} \pm 6.44$ | $14.29^{cd} \pm 0.70$ | 38.78 ± 2.05 | $0.37^{ab} \pm 0.03$ | 0.32 ± 0.04 |
| 10 X S | $0.34^{de} \pm 0.08$ | $6.54^{abc} \pm 0.70$ | $82.90^{abc} \pm 4.43$ | $14.91^{a} \pm 0.75$ | 38.89 ± 2.37 | $0.38^{ab} \pm 0.02$ | 0.33 ± 0.02 |
| 5 X NS | $0.72^{c} \pm 0.18$ | $5.74^{cd} \pm 0.52$ | $77.51^{cd} \pm 3.88$ | $14.7^{bcd} \pm 0.82$ | 39.11 ± 2.03 | $0.38^{ab} \pm 0.03$ | 0.32 ± 0.04 |
| 5 X S | $0.10^{e} \pm 0.09$ | $6.82^{ab} \pm 0.56$ | $84.7^{ab} \pm 3.26$ | $15^{abc} \pm 1.18$ | 38.67 ± 3.74 | $0.39^{ab} \pm 0.05$ | 0.33 ± 0.02 |
| 0 X NS | $0.00^{e} \pm 0.00$ | $6.98^{a} \pm 0.48$ | $85.72^{a} \pm 2.85$ | $15.70^{a} \pm 0.66$ | 39.56 ± 0.73 | $0.40^{a} \pm 0.01$ | 0.32 ± 0.02 |
| 0 X S | $0.00^{e} \pm 0.00$ | $7.01^{a} \pm 1.04$ | $85.52^{a} \pm 6.37$ | $15.83^{a} \pm 0.35$ | 40.56 ± 1.59 | $0.40^{a} \pm 0.01$ | 0.34 ± 0.04 |

Data are expressed as mean ± SD. Means within the same column with the same superscript are not significantly ($P < 0.05$) different. And Ht=height;Wd=width

The effect of storage duration (0/fresh, 5, 10 and 15 days) and spraying groundnut seed oil on yolk height of medium sized WLH eggs was examined. There was no significant difference in yolk height between non-sprayed eggs stored for 5 and 10 days. Significant difference was observed among sprayed eggs stored for 10 days and non-sprayed one having the same storage period. There were no significant differed that was observed in yolk width among all treatments. The effect of storage and oil spraying was not clearly observed with yolk width measurements.

The yolk index was not significantly differed between non-sprayed eggs stored for 15 and 10 days but it was significantly different from fresh eggs.but no significant difference was detected between non-sprayed eggs stored for 10 days and 5 days. Non-sprayed eggs stored for 15 days showed a relatively lower yolk index than any of the treatments. On the other hand, a higher yolk index values were recorded on fresh eggs. There was not significantly differed in yolk index among sprayed and 15 days stored (0.38), sprayed and 10 day stored (0.38), non-sprayed and stored for 10 days (0.37), non-sprayed and stored for 5 days (0.38) and sprayed and stored for 5 days (0.39) (Table 2). Yolk indices were influenced by the interaction effect of storage and oil spraying. The effect of storage and oil spraying was not significantly differed on average shell thickness of all eggs used in the experiment.

### *Effect of storage and oil spraying on nutrient composition of chicken eggs*

There was significant difference ($P < 0.05$) in the percentage of moisture content of eggs among non-sprayed eggs kept for different storage period. There was gradually decreased in moisture content as the storage period advances. Oil sprayed eggs stored for 15 days maintained better moisture than non-sprayed eggs stored for the same storage period. The lowest moisture percentage was recorded on non-sprayed eggs stored for 15 days. A percent moisture content of 5.62, 5.62, 5.64 and 5.66 were recorded on sprayed eggs stored for 15, 10, 5 and 0 day stored eggs respectively. While moisture percentage of 4.93, 4.95, 5.13 and 5.7 respectively were recorded on non-sprayed eggs kept for the same storage duration.

There was significantly differed ($P < 0.05$) between non-sprayed eggs stored for 0, 5, 10 and 15 days. 15 days stored sprayed eggs had relatively greater (33%) fat than non-sprayed eggs (32.28%) with the same storage period. 10 days stored sprayed eggs had better fat percentage than their respective non-sprayed eggs. Fresh eggs had more fat percentage than others. There was not significantly differed in ash and carbohydrate content of eggs.

**Table 3.** Effect of spraying groundnut seed oil, storage duration and their interaction on nutrient composition of chicken eggs

| Nutritional composition | Effect of storage duration | | | | Effect of oil spraying | |
|---|---|---|---|---|---|---|
| | 0 day | 5 days | 10 days | 15 days | Non-sprayed | Sprayed |
| **Moisture %** | $5.7^{a}\pm 0.04$ | $5.13^{b}\pm0.27$ | $4.95^{b}\pm0.05$ | $4.93^{b}\pm 0.02$ | $5.17^{b}\pm 0.33$ | $5.63^{a}\pm0.06$ |
| **Fat (%)** | $33.84^{a}\pm 0.06$ | $33.24^{ab}\pm 0.87$ | $32.73^{b}\pm 0.11$ | $32.28^{b}\pm 0.31$ | $33.02^{b}\pm0.32$ | $33.49^{a}\pm0.07$ |
| **Ash (%)** | 1.45 ± 0.08 | 1.33 ±0.28 | 3.44 ± 0.1 | 3.43 ± 0.03 | 2.41 ± 0.61 | 2.3 3 ±0.12 |
| **Protein (%)** | $39.38^{a}\pm0.32$ | $37.91^{ab}\pm0.03$ | $36.65^{ab}\pm0.33$ | $36.06^{b}\pm 0.05$ | $37.50^{b}\pm 0.27$ | $38.93^{a}\pm 0.45$ |
| Carbohydrate (%) | 19.71± 2.12 | 21.26 ± 2.12 | 22.68 ± 0.02 | 22.86 ± 0.05 | 21.67 ± 0.19 | 19.68 ± 0.11 |

| Interaction effect (STR * SPR) | Parameters Moisture % | Fat (%) | Ash (%) | Protein (%) | Carbohydrate (%) |
|---|---|---|---|---|---|
| 15 X NS | $4.93^{b}\pm 0.02$ | $32.28^{b}\pm 0.31$ | 3.43 ± 0.03 | $36.06^{c}\pm 0.05$ | 22.86 ± 0.05 |
| 15 X S | $5.62^{a}\pm 0.03$ | $33^{a}\pm 0.31$ | 2.65 ± 0.52 | $38.25^{ab}\pm 0.4$ | 20.17 ± 0.51 |
| 10 X NS | $4.95^{b}\pm 0.05$ | $32.73^{b}\pm 0.11$ | 3.44 ± 0.1 | $36.65^{b}\pm0.33$ | 22.68± 0.02 |
| 10 X S | $5.62^{a}\pm 0.09$ | $33.59^{a}\pm 0.01$ | 3.02 ± 0.67 | $38.74^{a}\pm0.38$ | 19.62 ± 0.05 |
| 5 X NS | $5.13^{b}\pm 0.27$ | $33.24^{ab}\pm 0.87$ | 1.33 ±0.28 | $37.91^{abc}\pm0.03$ | 21.26 ± 2.12 |
| 5 X S | $5.64^{a}\pm 0.07$ | $33.63^{ab}\pm 0.11$ | 2.31 ± 1.25 | $39.04^{a}\pm 1.25$ | 19.96 ± 0.82 |
| 0 X NS | $5.7^{a}\pm 0.04$ | $33.84^{a}\pm 0.06$ | 1.45 ± 0.08 | $39.38^{a}\pm0.32$ | 19.71± 2.12 |
| 0 X S | $5.66^{a}\pm 0.04$ | $33.78^{a}\pm 0.05$ | 1.34 ± 0.3 | $39.69^{a}\pm 0.3$ | 19.72 ± 0.03 |

Data are expressed as mean ± standard deviation. Means within the same column with different superscripts are significantly ($P < 0.05$) different. Where; S=Sprayed; NS=Non-sprayed; STR=storage and SPR=spraying

Protein content of 15 days stored non-sprayed eggs was lower than any of the eggs stored for the experiment. Protein percentage was not significantly differed between 15 and 10 days stored sprayed eggs. 15 day stored sprayed eggs had greater protein percentage than 15 day stored non-sprayed eggs. But there was not significantly differed in the percentage of protein between 5 days stored sprayed eggs and fresh eggs.

## Discussion

### *Effect of storage and oil spraying on chicken eggs quality*

A progressive increase in average weight loss on both sprayed and non-sprayed eggs was recorded as the duration of storage increased. This is in agreement with many researchers like Dudusola (2009) who proved this statement using Japanese quail eggs in Nigeria, and Bhale *et al*. (2003) stated the application of coatings on eggs reduced weight loss and maintained their internal parameters such as yolk and albumin height and sensory evaluation of eggs. The weight loss increment was due to water and gases loss because of exposed temperature. However, the lower weight loss percentage of sprayed eggs was due to blockage of shell pores with groundnut seed oil, thus preventing gaseous or water escape. This result was slightly lower than the reported value (3.397%) by Caner (2005) on eggs stored for 2 weeks. This difference may be due to differences in environmental factors. Bhale *et al.* (2003) stated differences in weight loss may be due to temperature, storage period, shell porosity or egg size. The average weight loss percentage of eggs stored for 10 days and sprayed with groundnut oil was 0.34% which was lower in weight loss percentage than the non-sprayed eggs stored for 5 and 10 days. Caner (2005) found a weight loss of 3.397% for control, 2.108% for chitosan-coated eggs, 1.997% for WPI- coated eggs, and 0.447% for shellac-coated eggs over a 2-week experiment at room temperature.

### *Internal quality of chicken eggs*

Albumin height can give the measure of freshness of the eggs, because the inner thick albumin height decreases with storage time (Caner, 2005). In this study, the height of albumen was decreased as the storage period increased. As cited by Raji (2009), Jones and Musgroov (2005) who testified a decrease in eggs weight and albumin height with storage leading to decrease weight of eggs. A relatively lower albumen height (3.04 ±0.21) was observed on non-sprayed eggs stored for 15 days. But fresh /0 day stored eggs had an albumen height of

(7.01mm). It was slightly closed with the results of Raji (2009) who reported as 0.73 cm. This slight difference could be due to egg size difference. Interaction effect was observed to be significant on albumen height.

During egg storage, the albumin PH increased, and it is related to the deterioration of albumin quality (Benton and Brake, 2000). This may also be due to the degradation of thick albumen as it is stored longer. Sprayed eggs stored for 15 days had a greater albumen height (5.91±0.84 mm) than non-sprayed one (3.04±0.21 mm) having the same storage period. The sprayed eggs were observed to be greater in albumen height within each storage period than non-sprayed eggs. Jones and Musgroove (2005) reported an albumen height of 7.05, 6.65 and 5.84mm for 0, 1 and 2 weeks stored eggs respectively.

In the current study, Haugh unit value was decreased progressively as the storage length increased. This is in line with Jones *et al*., (2002) who revealed as HU decrease during storage. Fresh eggs were observed to be relatively higher in Haugh unit (85.72 ± 2.85) than any of the eggs stored during the experiment. This result is slightly greater than the HU value (79.07) recorded by Bhale *et al*. (2003), and lower than the HU value of commercial eggs (87) reported by Farrell, (1998). Non-sprayed eggs stored for 15 days showed a relatively lower in Haugh unit value (52.45 ± 2.66) than sprayed eggs exposed from the same storage period (78.52 ±5.86). Farrell (1998) reported the HU value of 46.5 for the commercial eggs stored for 15 days. While Monira *et a*l. (2003) revealed HU value of 50.1 for eggs stored for 14 days. This slight disagreement may be due to environmental temperature difference. In general, as the storage period advances, the Haugh unit value decreased. This is in agreement with Caner (2005) who showed the yolk-index and Haugh unit values of all uncoated eggs were significantly lower than those of coated. This was due to egg pores blockage with oil so that albumen height and weight loss are maintained through moisture and gases prevention from loss.

The lowest yolk height was recorded on non-sprayed eggs at 15$^{th}$ day of storage (13.66mm). this result is not in agreement with the records of Raji *et al*, (2009) which was 11.4mm, it slight differed is due to the hot climatic condition of experimental site. Fresh eggs were found to be greater in yolk height than any of the eggs stored. Raji *et al.* (2009) reported a yolk height of 16.7 for the fresh eggs. As egg's storage period advances, yolk height was decreased. This is in agreement with Raji *et al.* 2009 who showed a decline in yolk height from 16.7 to 9.7mm within 28 days of storage. It is due to $CO_2$ loss and break down of carbonic acid to carbon dioxide that cause mucin fibre which gives the yolk and albumin their gel-like texture to loss their structure and the yolk and albumin become more water (Mountney, 1976). Interactions effect of storage durations and oil spraying had significantly influenced ($P<0.05$) the mean value of egg yolk height during the experiments.

There was not significantly differed in yolk width among all treatments. There was not significant differed in the effect of storage and oil spraying on yolk width measurements is in agreement with Raji *et al*. (2009) who recorded a yolk width of 3.75 and 5.44 for fresh and 28 day stored eggs respectively. Significant difference in yolk width was noted when eggs stored for more than 15 days. Yolk width was not influenced by the interaction effect of storage duration and oil spraying.

Yolk index value in fresh eggs was lower than the other treatment groups which is in line with the statement ‘’thick albumin and yolk index decreased with length of storage stated by Haugh (1937) as cited by Dudusola, (2009). This deterioration is attributed to a progressive weakening of vitelline membranes and liquefaction of the yolk due to diffusion of the egg white into the yolk (Obanu and Mpieri, 1984; Stadelman, 1995). Chang and Chen (2000) stated as yolk indices and Haugh unit are generally taken as good indicators to measure egg quality.

Quality of eggshell is one of the main important factors that affect hatchability (Roque and Soares, 1994). The porosity and eggshell thickness help to control the exchange of oxygen and carbon dioxide between the developing embryo and the air during incubation (Roque and Soares, 1994). Egg shell thickness has significant effect on moisture loss during incubation (Bennett, 1992). Thin-shelled eggs lose more moisture than thick-shelled eggs which leads to difficulty hatching (Roque and Soares, 1994). An average shell thickness value of 0.33, 0.32, 0.32 and 0.32 were recorded on 15, 10, 5 and 0 days stored eggs. Monira *et al.* (2003) recorded a shell thickness of 0.35, 0.37 and 0.36 for 1, 7 and 14 days stored eggs respectively.

### *Effect of storage and oil spraying on nutrient composition of chicken eggs*

Sprayed eggs were shown to have relatively better tendency to keep moisture from loss than their respective storage period. Ndife *et al*. (2010) reported a value of 45.21, 8.94, 6.74, 1.02 and 38.09 percent for Protein (%), Fat (%), Moisture (%), Ash (%) and Carbohydrate (%) respectively for the whole egg dried in an oven at $44^0$C. It is slightly varied due to drying temperature difference.

Generally, oil spraying can minimize protein loss as the storage period increased. Dudusola (2009) reported a gradually decreased in the values of the crude protein, ether extract, moisture and ash content on eggs of quail stored for different period (0, 4, 7 and 21days). Moisture, fat and protein percentage were influenced by storage and oil spraying interaction, but carbohydrate and ash percentage were not affected.

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