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# Effect of Storage Days and Temperature on Fertile and Non Fertile Egg Quality Characteristics and Sensory Evaluation

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## Abstract:

This experiment was conducted in the Animal Products and Processing laboratory, Department of Animal Production, University of Jos, Jos-North Local Government Area (LGA) of Plateau State to evaluate the main effect of temperature and storage days on fertile and non fertile egg on the egg quality characteristics. A total of 600fertile and non-fertile eggs was collected from Poultry Division of National Veterinary Research Institute, Plateau State (NVRI). Eggs were obtained from Lohmann brown hen, at 44 weeks of age to evaluate egg quality characteristics. Out of the 300 eggs in each of the storage methods, eggs were picked at random after the following storage days (5, 10, 15 and 20 respectively)for determination of egg quality characteristics and the remaining eggs were used at every storage days for sensory evaluation in 2 x 2 Factorial arrangement in a completely randomized design. The storage methods were room temperature (ambient) and refrigeration (100C).External and internal quality characteristics of eggs were taken, which are egg length, width (cm) and weight was measured and its shell weight was taken as the weight of the air dried egg shell. The shell thickness which is the thickness of the dried egg shell was measured. Samples for sensory evaluations was taken from both fertile and non-fertile eggs, total of 20 trained individuals aged between 22-35 years males and females were used. Data were analysed using descriptive statistic and ANOVA at α0.05. There was significant difference ($p<0.05$) between fertile and non-fertile eggs external and internal characteristics. Both the fertile and non-fertile eggs weight under the refrigerator had the highest values while Both the fertile and non-fertile eggs weight under the room temperature had the lower egg weight values. Significant difference ($p>0.05$) existed among all yolk parameters measured except yolk colour. Yolk weight, height and index were significantly higher in fertile egg stored in the refrigerator while fertile egg stored in the refrigerator has the lowest yolk weight and ratio. There was significant difference ($p<0.05$) that existed in albumen weight, albumen height, albumen ratio and albumen index for fertile and non-fertile. The albumen height was higher in fertile eggs stored at refrigerator temperature while non-fertile eggs stored at room temperature had the least height. Non-fertile eggs stored at room temperature and refrigerator temperature had the highest albumen length 108.88cm and 100.80 cm respectively with least length in fertile eggs stored at the refrigerator. The haugh unit of fertile egg stored in refrigerator is significantly higher ($p<0.05$) than all the storage method. There was no significant difference ($p>0.05$)

that existed for odour, aroma, taste, texture and overall acceptability for all the treatments. The egg weight was significantly ($p<0.05$) higher at storage day 10, than all the storage days. The yolk weight for storage day 10 was significantly ($p<0.05$) higher than all the storage days. The yolk diameter for storage days 5, 10 and 15 were statistically similar ($p>0.05$). The yolk colour was significantly ($p<0.05$) higher on storage day 15 and lower on day 0. The albumen heights decreased significantly ($p<0.05$) as the days of storage increased. The albumen length at storage day 20 was significantly ($p<0.05$) higher than all the storage days. The haugh units decrease significantly ($p<0.05$) during the period of storage. In conclusion, fertile eggs can be stored in refrigerator for 10 to 15 days without adverse effect on egg qualities.

## Keywords:
Fertile Eggs, Non-Fertile Eggs, Storage Days, Storage Temperature, Egg Quality

## 1. Introduction

Eggs are excellent sources of high quality protein and are also good sources of iron, vitamin (except vitamin C) and phosphorus but are low in calcium. Egg protein is usually referred to as "HBV" protein, meaning protein with High Biological Value. Eggs consist of a complete range of amino acids including branch chain amino acids (methionine and cysteine), lysine, tryptophane and other essential amino acids thus earning the title- " Complete Protein" [1]. Eggs are good sources of vitamins B1, B2, B3, B5, B6, B12, choline, Biotin, Folic acid and also contains selenium and iodine making eggs an excellent food for infants, children, adolescents, convalescents and older people [2]. Raw egg white contains a glycoprotein called avidin which binds with biotin to form an avidin-biotic complex which cannot be absorbed by the human digestive tract, however, cooking denatures avidin glycoprotein making it unable to bind with biotin [1].

Internal and external qualities of eggs deteriorate with time. This process of deterioration cannot be stopped but the rate at which it occurs can be reduced [3]. These changes occur as a result of biological and physico-chemical occurrences mainly due to proteolysis and movement of bacteria into egg shell under poor storage conditions [4]. Freshly laid eggs contain few organisms capable of causing spoilage but washing of eggs or storing of eggs in damp conditions cause bacteria to penetrate and multiply causing green, black, and red rots and mold spores on egg to germinate, grow and penetrate the egg shell [2]. Condensation following removal of eggs from refrigerated storage into ambient temperature also provides favorable conditions for the penetration of bacteria [2].

The main degradation factors for eggs are storage days (time) [5], temperature, humidity, air movement, and handling [6,7]. Internal quality deterioration of eggs can be retarded significantly by maintaining storage temperature, because quality deterioration occurs faster at high temperatures than at refrigerated temperatures during storage [8,9]. Egg storage influences the rate at which eggs undergo physical and biochemical changes that lead to the reduction in egg quality thus influencing its nutritional composition and acceptability for consumption and other uses [10,11,12,13,14].

According to [15] egg quality refers to the characteristics of an egg that will affect its acceptability to the consumer. It then becomes necessary to properly store eggs in

order to maintain its quality and also to derive maximum utility from utilization of eggs.

Therefore, this study aims at identifying a suitable method that will significantly reduce the rate at which biological and physiochemical changes occur within the egg with respect to storage and temperature.

## 2. Materials and Methods

### *2.1. Experimental Site*

This experiment was conducted in the Animal Products and Processing laboratory, Department of Animal Production, University of Jos, Jos-North Local Government Area (LGA) of Plateau State. It is situated at the extreme North of the State and located between latitude 90 E55' North of the Greenwich meridian and longitude 80 E54' East of the Equator [16].

### *2.2. Collection of Experimental Material*

A total of 600fertile and non-fertile eggs was collected from Poultry Division of National Veterinary Research Institute, Plateau State (NVRI) in four successive weeks were used for this study. Eggs were obtained from Lohmann brown hen, at 44 weeks of age to evaluate egg quality characteristics. Out of the 300 eggs in each of the storage methods, 20 were picked at random after the following storage days (5, 10, 15 and 20 respectively)for determination of egg quality characteristics and the remaining eggs were used at every storage days for sensory evaluation. The storage methods were room temperature (ambient) and refrigeration. Where fertile and non fertile eggs were randomly assigned as follows;

## 3. Sampling Procedure

### *3.1. Sampling and Storing of Egg*

Immediately after egg collection, eggs were labeled and numbered using a non-harmful permanent marker. Eggs were weighed according to date of collection by using sensitive scale. To study the effect of storage days on egg quality parameters, eggs were stored in refrigerator at 10 °C, ambient(room)temperature of 28-31 °C for 5, 10, 15 and 20 days, and humidity was 55 to 60% for all treatments. The stored eggs were identified and analyzed at each corresponding storage days and temperature.

### *3.2. Evaluation of Egg Quality*

External quality characteristics of eggs were taken, which are egg length and egg width (cm), were measured with a digital vernier caliper, egg weight was measured by weighing egg individually using a sensitive scale, and its shell weight was taken as the weight of the oven dried egg shell. The shell thickness which is the thickness of the dried egg shell was measured with a micrometer screw gauge (the mean of the three points- narrow, broad and middle was taken as the shell thickness). After this process, eggs were carefully cracked with a spoon in a flat plate on a table without breaking the vitelline membrane, in order to measure the internal quality characteristics. The parameters were then taken immediately. The internal parameters measured were:

Yolk Width: Measured as the widest horizontal circumference with a vernier caliper.

Yolk Height: Measured as the height of the yolk at mid-point with a tripod micrometer.

Albumen Height: Measured as the height of the thick albumen.

Albumen Width: Measured as the widest horizontal circumference and,

Albumen Weight: Calculated as the difference in weight of the egg and weight of the yolk plus shell.

Yolk Index: Was calculated as the yolk height divided by the yolk width (cm).

Albumen Index: Is the ratio of the albumen height to egg width.

Haugh unit was determined using the formula below:

HU= 100log (H+ 7.5- 1.7W ^0.35)

Where HU= Haugh unit

H= Height of the thick albumen (mm)

W= Egg weight (grams)

### *3.3. Sensory Evaluation*

At every storage days, eggs from each treatment were sampled for sensory evaluation. Samples for sensory evaluations was taken from both fertile and non fertile eggs, total of 20 trained individuals aged between 22-35 years males and females from department of Animal Production University of Jos, Plateau State. Were employed to assess the coded egg samples. Equal bite size from each treatment was coded, replicated thrice and served for evaluation by the trainees on a 9-point hedonic scale for colour, aroma, odour, taste, texture and overall acceptability. The eggs were cooked by bringing tap water to boil at 100oC and simmer for 20 minutes. After being allowed to cool for 30 minutes under a fan. Eggs were shelled and presented to the trained 20-man panelist who judged using a nine point hedonic scale from 9(extremely like) to 1(extremely dislike). Cold distilled water was provided for panelists to rinse their mouth in between samples.

### *3.4. Experimental design*

2 x 2 Factorial arrangement in a completely randomized design.

### *3.5. Statistical Analysis*

Data collected were analyzed using General linear model of SAS [17]. Statistical variations were observed and means were separated using Duncan's multiple range test.

## 4. Results and Discussion

### *4.1. Results*

#### *4.1.1. Main Effect of Temperature Difference on Fertile and Non-Fertile Egg External and External Characteristics*

The main effect of temperature difference on fertile and non-fertile egg external and internal characteristics is shown in Table 1. There was significant difference ($p<0.05$) between fertile and non-fertile eggs external and internal characteristics. Both the

fertile and non-fertile eggs weight under the refrigerator had the highest values while Both the fertile and non-fertile eggs weight under the room temperature had the lowest values. No significant difference ($p>0.05$) was observed in the egg length and egg width of fertile and non-fertile eggs the during the storage method.

***Table 1.*** *Main effect of temperature difference on fertile and non-fertile egg external and internal characteristics.*

| | Fertile Egg | | Non-Fertile Egg | | |
|---|---|---|---|---|---|
| **Parameter** | **Room Temperature** | **Refrigerator Temperature** | **Room Temperature** | **Refrigerator Temperature** | **SEM** |
| Egg weight (g) | $67.18^{ab}$ | $68.72^{a}$ | $65.30^{b}$ | $69.24^{a}$ | 0.62 |
| Egg length (mm) | 56.76 | 58.52 | 57.94 | 58.00 | 0.31 |
| Egg Width (mm) | 49.96 | 44.84 | 44.30 | 44.96 | 0.19 |
| Yolk weight (g) | $16.84^{b}$ | $18.50^{a}$ | $18.40^{a}$ | $17.36^{ab}$ | 0.26 |
| Yolk height (mm) | $15.18^{ab}$ | $15.90^{a}$ | $13.82^{c}$ | $14.68^{bc}$ | 0.19 |
| Yolk diameter (mm) | $39.96^{bc}$ | $39.68^{c}$ | $41.40^{a}$ | $41.16^{ab}$ | 0.22 |
| yolk colour | 9.92 | 10.02 | 9.78 | 10.00 | 0.07 |
| Yolk ratio | $25.36^{b}$ | $26.94^{ab}$ | $28.21^{a}$ | $25.41^{b}$ | 0.34 |
| Yolk index | $38.23^{ab}$ | $40.14^{a}$ | $33.82^{c}$ | $36.00^{bc}$ | 0.54 |
| Albumen weight (g) | $42.38^{c}$ | $45.92^{b}$ | $42.68^{c}$ | $48.90^{a}$ | 0.62 |
| Albumen height (mm) | $5.56^{b}$ | $6.20^{a}$ | $4.62^{c}$ | $5.28^{b}$ | 0.11 |
| Albumen length (mm) | $97.74^{bc}$ | $93.50^{c}$ | $108.88^{a}$ | $100.80^{b}$ | 1.27 |
| Albumen ratio | $63.67^{b}$ | $66.69^{b}$ | $66.33^{b}$ | $71.65^{a}$ | 0.98 |
| Albumen index | $5.88^{c}$ | $6.78^{b}$ | $4.57^{d}$ | $7.41^{a}$ | 0.50 |
| Yolk:Albumen | $0.41^{a}$ | $0.41^{ab}$ | $0.44^{a}$ | $0.37^{b}$ | 0.01 |
| Haugh unit (%) | $68.89^{b}$ | $74.57^{a}$ | $60.06^{d}$ | $64.55^{c}$ | 1.05 |
| Egg surface area ($mm^2$) | $538.19^{ab}$ | $550.52^{a}$ | $523.13^{d}$ | $554.69^{a}$ | 5.00 |
| Shape index | 79.41 | 77.16 | 76.79 | 77.97 | 0.51 |

*a, b, c, d means with different superscripts on the same column differ significantly ($P<0.05$)*

However, the egg width of non-fertile egg stored in refrigerator was recorded to be the highest. Significant difference ($p>0.05$) existed among all parameters measured except yolk colour. Yolk weight, height and index were significantly higher in fertile egg stored in the refrigerator while fertile egg stored in the refrigerator has the lowest yolk weight and ratio. There was significant difference ($p<0.05$) that existed in albumen weight, albumen height, albumen ratio and albumen index for fertile and non-fertile. Albumen weight was higher in non-fertile egg stored at refrigerator temperature with least albumen weight in fertile egg stored at room temperature. The albumen height was higher in fertile eggs stored at refrigerator temperature while non-fertile eggs stored at room temperature had the least height. Non-fertile eggs stored at room temperature and refrigerator temperature had the highest albumen length 108.88cm and 100.80 cm respectively with least length in fertile eggs stored at the refrigerator. Albumen ratio was higher in non-fertile stores under refrigerator while the least value is obtained under room temperature. Non-fertile eggs stored under refrigerator had the highest albumen index with least value in eggs stored under room

temperature. The yolk: albumen, haugh unit and egg surface area shows significant difference ($p<0.05$) on both fertile and non-fertile eggs stored at room and refrigerator temperature. The haugh unit of fertile egg stored in refrigerator is significantly higher ($p<0.05$) than all the storage method. There was no significant difference ($p>0.05$) recorded for shape index.

Figure 1 shows the effect of temperature difference on sensory evaluation of fertile and non-fertile egg. There was no significant difference ($p>0.05$) that existed for odour, aroma, taste, texture and overall acceptability for all the treatments. However, there was significant difference ($p<0.05$) between fertile and non-fertile eggs colour. The colour for fertile eggs stored at ambient temperature and refrigerator temperature are statistically similar ($p>0.05$). While the colour for non-fertile eggs stored at room temperature was highest and non-fertile eggs at refrigerator temperature was recorded as the least.

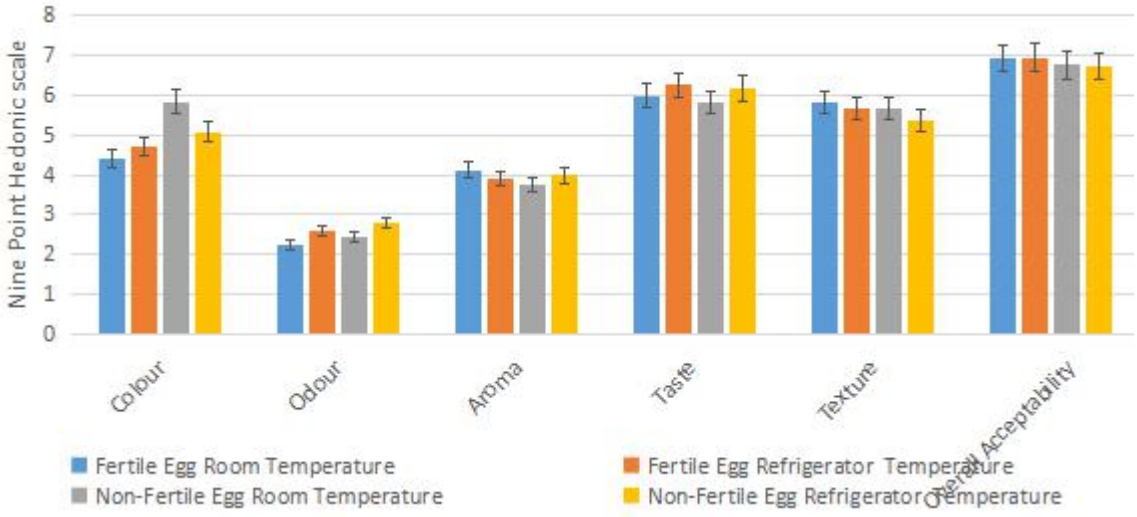



***Figure 1.*** *Effect of temperature difference on sensory evaluation of fertile and non-fertile eggs.*

### *4.1.2. Main Effect of Storage Days on Fertile and Non-Fertile Egg External and Internal Characteristics*

Table 2 shows the main effect of storage days on fertile and non-fertile egg external and internal characteristics. The egg weight was significantly ($p<0.05$) higher at storage day 10, than all the storage days. The egg length was recorded to be the highest at storage day 10, while the egg width was recorded the highest at storage day 20. The yolk weight for storage day 10 was significantly ($p<0.05$) higher than all the storage days. There was no significant difference ($p>0.05$) existed between the yolk heights on all the storage days.

The yolk diameter for storage days 5, 10 and 15 were statistically similar ($p>0.05$). The yolk colour was significantly ($p<0.05$) higher on storage day 15 and lower on day 0. The yolk ratio has the highest value at storage day 15 and yolk index has the highest at storage day 0 with low values at day 0 and day 20 respectively. There was no significant difference ($p>0.05$) in the albumen weight at storage days 0 and 5. Likewise no significant difference ($p>0.05$) in the albumen weight at storage days 15 and 20. The albumen heights decreased significantly ($p<0.05$) as the days of storage increased. However, the albumen height of eggs on storage days 0 was significantly ($p<0.05$) higher than all the storage days. While, the albumen length increases

significantly ($p<0.05$) as the days of storage increases. The albumen length at storage day 20 was significantly ($p<0.05$) higher than all the storage days. There was significant difference ($p<0.05$) in the yolk: albumen and egg surface area across the storage days while shape index shows no significant ($p>0.05$) difference. The haugh units decrease significantly ($p<0.05$) during the period of storage.

***Table 2.*** *Main effect of storage days on fertile and non-fertile egg external and internal characteristics.*

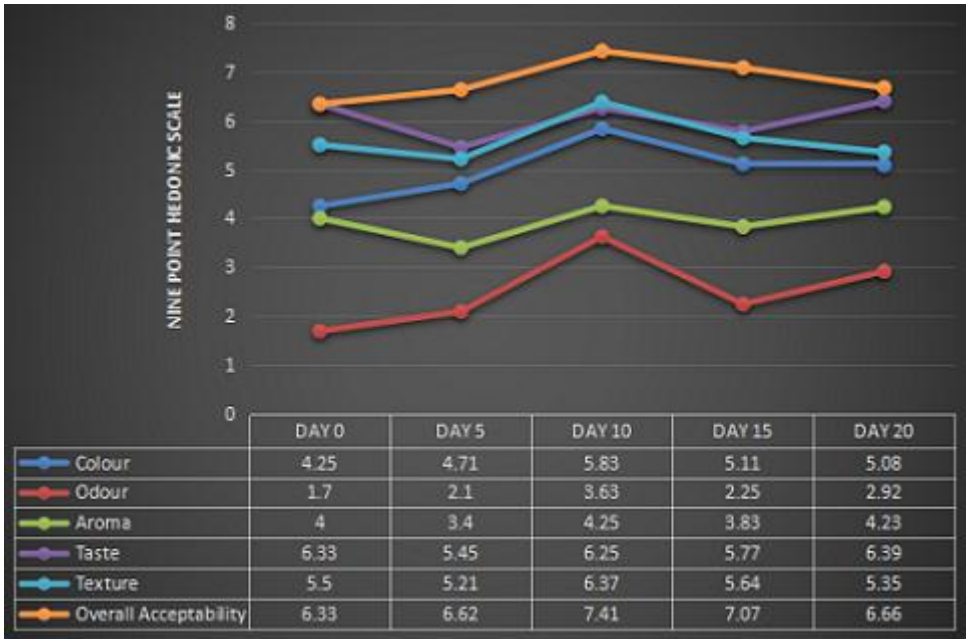
| Parameter | DAY 0 | DAY 5 | DAY 10 | DAY 15 | DAY 20 | SEM |
|---|---|---|---|---|---|---|
| Egg weight (g) | $62.80^{c}$ | $64.20^{c}$ | $79.15^{a}$ | $62.50^{c}$ | $69.40^{b}$ | 0.62 |
| Egg length (mm) | $56.55^{b}$ | $58.68^{ab}$ | $59.58^{a}$ | $57.05^{b}$ | $57.18^{ab}$ | 0.31 |
| Egg Width (mm) | $44.20^{ab}$ | $44.80^{ab}$ | $45.43^{a}$ | $43.55^{b}$ | $45.85^{a}$ | 0.19 |
| Yolk weight (g) | $15.55^{c}$ | $16.50^{bc}$ | $21.38^{a}$ | $17.45^{b}$ | $18.00^{b}$ | 0.25 |
| Yolk height (mm) | 15.08 | 14.8 | 15.2 | 14.65 | 14.75 | 0.19 |
| Yolk diameter (mm) | $37.92^{c}$ | $40.43^{b}$ | $40.78^{b}$ | $40.58^{b}$ | $43.05^{a}$ | 0.22 |
| yolk colour | $8.75^{c}$ | $9.85^{b}$ | $10.30^{ab}$ | $10.45^{a}$ | $10.30^{ab}$ | 0.07 |
| Yolk ratio | $24.90^{b}$ | $25.82^{ab}$ | $27.39^{ab}$ | $28.07^{a}$ | $26.26^{ab}$ | 0.35 |
| Yolk index | $39.88^{a}$ | $36.76^{b}$ | $37.37^{ab}$ | $36.71^{b}$ | $34.53^{b}$ | 0.54 |
| Albumen weight (g) | $37.90^{c}$ | $39.60^{c}$ | $44.38^{b}$ | $52.13^{a}$ | $50.85^{a}$ | 0.69 |
| Albumen height (mm) | $6.73^{a}$ | $6.18^{a}$ | $5.20^{b}$ | $4.70^{bc}$ | $4.28^{c}$ | 0.11 |
| Albumen length (mm) | $83.56^{c}$ | $98.68^{b}$ | $98.50^{b}$ | $110.95^{a}$ | $109.50^{a}$ | 1.28 |
| Albumen ratio | $60.49^{cd}$ | $61.63^{c}$ | $56.01^{d}$ | $83.55^{a}$ | $74.07^{b}$ | 0.98 |
| Albumen index | $8.19^{ab}$ | $8.71^{a}$ | $5.34^{abc}$ | $4.54^{bc}$ | $4.03^{c}$ | 0.54 |
| Yolk:Albumen | $0.41^{b}$ | $0.42^{b}$ | 0.49a | $0.35^{c}$ | $0.36^{c}$ | 0.01 |
| Haugh unit (%) | $80.30^{a}$ | $75.56^{a}$ | $61.36^{b}$ | $62.68^{b}$ | $55.15^{c}$ | 1.05 |
| Egg surface area (mm2) | $503.01^{c}$ | $514.31^{c}$ | $634.08^{a}$ | $500.69^{c}$ | $555.97^{b}$ | 5.00 |
| Shape index | 78.25 | 76.67 | 76.9 | 77.09 | 80.26 | 1.15 |

*a, b, c, d means with different superscripts on the same column differ significantly ($P<0.05$)*

### *4.2. Discussion*

Results from the study shows that, the egg weight, yolk height, albumen height, albumen weight, and the haugh unit decreases as the duration of storage increases. However, the yolk weight increases with storage days. Egg weight loss increases when storage duration increases, and the highest weight losses were recorded at 10 days of storage in both temperatures (room and refrigeration). Weight loss occurs due to loss of water from the egg content through the shell by evaporation. These results are not supported by [18,19,20,21,22,23,24], who reported that with increase in the length of storage days, egg weight losses increase. Likewise loss of egg weight depends on the temperatures. As a result, eggs stored at refrigerator temperature showed significantly ($p<0.05$) lower weight loss than room temperature. This may be due to the less loss of solvents (water and other gaseous products) from egg contents than those in room temperature. These results are in agreement with [7,25,26], who noticed a decrease in egg weight within 10 days of storage at 29 °C.

Yolk weight showed significant ($p<0.05$) changes during storage, and increased linearly with storage time, which might be due to the diffusion of water from the albumen to the yolk. These results agree with [27,28]. On the other hand, when the storage temperature was higher, the rate of increase in yolk weight was significantly ($p<0.05$) higher than in refrigeration (4°C). These results are supported by [29,30,31], who reported that the most important factors that affect egg quality during storage are temperature and relative humidity. (Figure 2)




| | DAY 0 | DAY 5 | DAY 10 | DAY 15 | DAY 20 |
|---|---|---|---|---|---|
| Colour | 4.25 | 4.71 | 5.83 | 5.11 | 5.08 |
| Odour | 1.7 | 2.1 | 3.63 | 2.25 | 2.92 |
| Aroma | 4 | 3.4 | 4.25 | 3.83 | 4.23 |
| Taste | 6.33 | 5.45 | 6.25 | 5.77 | 6.39 |
| Texture | 5.5 | 5.21 | 6.37 | 5.64 | 5.35 |
| Overall Acceptability | 6.33 | 6.62 | 7.41 | 7.07 | 6.66 |

***Figure 2.*** *Effect of storage days on sensory evaluation of fertile and non-fertile eggs.*

## 5. Conclusions

Since internal and external qualities of eggs deteriorate with time. This process of deterioration cannot be stopped but the rate at which it occurs can be reduced. Based on this study fertile eggs can be stored in refrigerator for 10 to 15 days without adverse effect on egg qualities.

## Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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