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EFFECT OF STORAGE METHODS AND TIME ON EGG QUALITY TRAITS OF LAYING HENS IN A HOT DRY CLIMATE

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ABSTRACT

The effect of storage methods and time on the external and internal egg quality traits of laying hens in a hot dry climate was examined. The traits were: egg weight, albumen and yolk height, albumen and yolk width, albumen and yolk indices, Haugh unit, egg width, egg length and shape index. The storage periods were 7, 14, 21 and 28 days while the methods were: room temperature (32^0C), oiling, refrigeration (5^0C) and high temperature (40^0C) storage. The effects of storage method and time were found to be significant ($P<0.05$) for all traits except egg width, egg length and shape index. Egg weight (58.37 to 51.22g), albumen (0.73 to 0.29cm) and yolk height (1.67 to 0.97cm), Haugh unit (83.37 to 34.0%), albumen (10.40 to 3.6%) and yolk indices (44.6 to 17.3%) decreased with increase in storage time while albumen (7.02 to 8.96cm) and yolk width (3.75 to 5.44cm) increased. Thus, lower egg quality was recorded with increased storage time. Refrigerated and fresh eggs gave comparable values respectively for Haugh unit (79.58 vs. 83.37%), albumen (0.70 vs. 0.73cm) and yolk height (1.64 vs. 1.67cm) indicating a minimal loss in quality. While oiling method gave values which were better than those of eggs stored at room temperature. Eggs stored at high temperature were already spoilt and not fit for consumption after 2 weeks of storage.

Keywords: eggs, storage method, quality, time, hens, hot dry climate.

INTRODUCTION

The poultry industry is an important segment of the world's food industry, providing eggs and meat to a large populace. Egg is one of the most nutritious foods available to man. It provides a balanced protein which contains all the amino acids considered essential in sufficient amounts and proportion to maintain life and support growth when used as a sole source of protein food (Ricketts, 1981). In addition, they have important functional properties (Kurtzweil, 1998). Egg production is on the increase in Nigeria and poor storage conditions may result in deterioration in egg quality and consequently, loss and waste of eggs. Moreover, the economic success of a laying flock depends on the number of quality eggs produced. Egg quality comprises a number of aspects related to the shell, albumin and yolk and may be divided into external and internal quality (Kul and Seker, 2004).

According to Keener *et al.* (2005) Haugh unit is a measure of albumen quality and therefore freshness of the egg while Silversides *et al.* (1993) proposed measuring albumen height to determine egg quality. Scott and Silversides (2000) and Jones and Musgroove (2005) reported a decrease in albumin height and weight of eggs with storage leading to decreased egg weight. Williams (1992) and ACIAR (1998) observed that oiling of eggs within 24 hours of lay was effective in retarding albumin deterioration but does not replace the need for cool storage. According to Samli *et al.* (2005) storage time and temperature appear to be the most crucial factors affecting albumin quality or Haugh unit. In some parts of Nigeria, most of the available eggs are usually stored at room temperature until they are completely sold or consumed because facilities for refrigeration are almost non existent. Room temperature in the semi arid region of Nigeria could be as high as 35^0C in the dry hot season when ambient temperature reaches 40 -45^0C. This study was undertaken to provide information on the effect of storage time and method on egg quality traits of laying hens in a hot and dry environment of Nigeria.

MATERIALS AND METHODS

The study was carried out at the poultry unit of the University of Maiduguri Livestock Teaching and Research Farm, Maiduguri, Borno State. Maiduguri, the Borno State capital is situated on latitude $11^0 5^1$ N longitude $13^0 09^1$E (Encarta, 2007) and at an altitude of 354m above sea level. The area falls within the Sahelian (Semi arid) region of West Africa, which is noted for its great climatic and seasonal variation. It has very short period (3-4 months) of rainfall giving 645.9mm/annum with a long dry season of about 8-9 months. The ambient temperature could be as low as 20^0C during the dry cold (Oct.-Jan.) season and as high as 44^0C during the dry hot (Feb. - May) season. Relative humidity is 45% in August which usually lowers to about 5% in April and May. Day length varies from 11-12 hours. A total of 340 newly laid eggs were collected from the birds in the poultry unit and used for the study. The birds, which are of the Bovans brown strain were housed in battery cages and fed a commercial layer ration containing 16% crude protein and 2500kcal/kg of energy *ad libitum*. Clean drinking water was also given *ad libitum*. 20 eggs were selected at random for determination of internal and external egg quality traits immediately after lay. These served as the values for the newly laid eggs. The remaining 320 eggs were divided into 4 groups of 80 eggs each. The groups were randomly allocated to one of the following storage methods: room temperature (32^0C), oiling, refrigeration (5^0C) and high temperature (40^0C) storage. Of the 80 eggs in each of the storage methods, 20 were picked at random after the following storage times (7, 14, 21 and 28 days) for determination of egg quality traits. Eggs for

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refrigeration were kept in the fridge compartment of the refrigerator. Oiling method involved spraying the eggs with groundnut oil, allowing them to drain before placing in egg flats and storing at room temperature. High temperature storage involved keeping the eggs in a chamber where temperature could be maintained at 40^0C. While for room temperature storage, eggs were placed in a well ventilated room with an average temperature of 32^0C. The external egg quality parameters such as egg length and egg width were measured with a vernier caliper in centimeters and egg shape index was obtained as a ratio of the egg width to the length. For internal egg quality traits, individual egg samples were broken out on a flat white tile being cautious not to break the vitelline membrane that enclose the yolk. The 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 the mid point with a tripod micrometer.

Albumen height-this was measured as the height of the chalazae at a point midway between thinner and outer circumference of the white with a tripod micrometer

Shell thickness- this is the thickness of the dry eggshell measured with a micrometer screw gauge. The mean of three points (the narrow, broad and middle) was taken as shell thickness. Haugh unit was determined using the formula below:

$$HU = 100 \log (H + 7.5 - 1.7W^{0.37})$$

where
HU = Haugh unit
H = height of albumen
W = egg weight (grams)

Data collected were analyzed using SPSS 11.0 with storage time and method as fixed factors. Significant means were separated by the Duncan's multiple range Test. The statistical model adopted was as follows:

$$Y_{ijk} = \mu + A_i + B_{ij} + e_{ijk}$$

where
Y_{ijkl}= observation on the k^{th} egg trait at an i^{th} storage time under a j^{th} storage method.
μ = population mean
A_i= effect of i^{Th} storage time
B_{ij} = effect of the j^{Th} storage method
e_{ijkl} = random error

RESULTS AND DISCUSSIONS

The effect of storage method on the external and internal egg quality traits were found to be significant ($P<0.05$) for all traits except egg width, egg length and shape index. The means and standard errors of the fresh eggs and the different storage methods (room temperature, oiling, refrigeration and high temperature) are presented in Table-1. While Figures 1 and 2 show the trend in some quality traits as affected by these storage methods. The weight of the eggs before storage was 58.36g while the weights after storage were 50.59g, 51.70g and 54.81g for room temperature, oiling and refrigeration storage, respectively. These means were significantly different from the fresh egg. The egg stored at high temperature (40^0C) was no longer fit for consumption after 2 weeks of storage. There was a general decline in egg weight from 58.36g to 50.59g with storage especially at high temperature. These decreases in egg weight with storage has been reported by Samli *et al.* (2005) who observed a decrease in weight within 10 days of storage at 29^0C. Refrigerated and oiled eggs had lower ($P<0.05$) egg weight loss, probably due to less moisture loss from the eggs as reported by ACIAR (1998). The albumen and yolk height of fresh eggs were not different ($P>0.05$) from the refrigerated eggs but differed ($P<0.05$) from the oiled and room temperature stored eggs which also differed ($P<0.05$) from each other.

The albumen and yolk width of fresh, oiled and refrigerated eggs did not differ ($P>0.05$) from each other but were significantly ($P<0.05$) different from those of eggs stored at room temperature. The decrease in albumen and yolk height with increasing temperature observed in this study corroborates the findings of ACIAR (1998); Scott and Silversides (2000); and Samli *et al.* (2005). It was also observed that the refrigerated eggs were able to retain their albumen and yolk heights while oiled eggs had values close to those of the refrigerated eggs compared to the others. The difference between the various methods to maintain egg quality could be due to their varying ability to retard carbon dioxide loss and breakdown of carbonic acid to carbon dioxide. This is because these losses cause Mucin fibre which gives the albumen and yolks their gel-like texture to loss their structure and so the albumen and yolk becomes watery (Mountney, 1976). He further enumerated that as the albumen and yolk becomes watery, there is a loss of albumen and yolk height, thus a decline in the egg quality in storage.

Means and standard error of the egg quality traits for the four storage times are presented in Table-2. The effect of storage time on external and internal egg quality traits were found to be significant ($P<0.05$) except egg length, egg width and shape index. Mean weight of the fresh eggs (day 1) at the start of the study was 58.35g and served as the reference value. The mean egg weight for day 7, 14, 21 and 28 of storage were 54.34, 51.84, 51.47 and 51.22g respectively. The weight of fresh eggs was significantly different ($P<0.05$) from the stored eggs with a progressive loss in weight from day 7 to day 28. Similarly, albumen height on day 1, 7, 14, 21 and 28 of storage were 0.73, 0.51, 0.51 0.48 and 0.39 respectively. Haugh unit and yolk height followed a similar trend. The trends are shown in Figures 3, 4 and 5. The values of egg quality traits obtained for the fresh eggs were close to those reported for fresh eggs by Abannikanda *et al.* (2007). The consistent decrease in egg weight with increased storage time observed in this study is consistent with the reports of ACIAR (1998) and Samli *et al.* (2005). However, Scott and Silversides (2000) reported that for some unexplained reasons, egg weight did not change in the first 10 days of storage. However, the average temperature in their study site was 20.2^0C which was much below the room temperature of 32^0C reported in this study.

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Dramatic deteriorations were observed in albumen height (0.73 to 0.29cm), Haugh unit (83.37 to 34.0%) and yolk height (1.68 to 0.97cm) with storage. These results are in agreement with those of Scott and Silversides (2000) and Samli *et al.* (2005). Samli *et al.* (2005) also reported significant (P<0.001) decrease in egg weight, albumen height, Haugh unit, albumen and yolk indices with increase in storage time. In their study, albumen height decreased from 9.16 to 4.75mm, Haugh unit from 91.4 to 40.6 and yolk index from 44.1 to 32.7 within 10 days of storage. In addition, the increase in albumen and yolk width observed in this study has also been reported by Keener *et al.* (2006).

The general decline in albumen and yolk quality as eggs aged is in agreement with the findings of Fasenko *et al.* (1995); Monira *et al.* (2003) and Miles and Henry (2004) who observed a decline in albumen and yolk indices with increase in storage time.

CONCLUSIONS

From the study, it was observed that egg weight, albumen and yolk height, Haugh unit, albumen and yolk indices decreased with increase in storage time while albumen and yolk width increased. Egg length and width were not affected by storage time and method. It can be concluded that the quality of an egg is affected by the method and length of storage. Eggs kept at high temperature 40^0C deteriorated in quality very fast and were not fit for consumption after two weeks. Refrigerated eggs were able to maintain their quality comparable to the fresh eggs. Oiling of eggs also maintained egg quality to some extent but oiling is not a replacement for refrigeration. It may however serve for 28 days were refrigeration facilities are not available and eggs must be stored. In the hot dry climate, where ambient temperatures can reach 40-45 ^{0}C, eggs should not be stored at room temperature, for more than one week before consumption.

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Table-1. External and internal egg quality traits as affected by storage method.

^{a,b,c} means within rows with different superscript are significantly ($P<0.05$) different from each other

Egg quality traits	Fresh egg	Room temperature (32^{0}C)	Oiling	Refrigeration (5^{0}C)	High temperature (40^{0}C)
Egg weight (g)	58.37 ± 1.43^{a}	50.59 ±1.01^{c}	51.70 ±1.01^{bc}	54.81 ±1.01^{b}	52.17 ±1.43^{bc}
Egg width (cm)	4.26 ±0.07^{a}	4.36 ±0.05^{a}	4.33 ±0.05^{a}	4.30 ±0.05^{a}	4.35 ±0.07^{a}
Egg length (cm)	5.70± 0.09^{a}	5.66 ±0.07^{a}	5.58 ±0.07^{a}	5.65 ±0.07^{a}	5.66 ±0.09^{a}
Albumin height (cm)	0.73± 0.04^{a}	0.40 ±0.03^{c}	0.53 ±0.03^{b}	0.70 ±0.03^{a}	0.31 ±0.04^{c}
Albumin width (cm)	7.02 ±0.26^{b}	9.13 ±0.18^{a}	7.50 ±0.18^{b}	7.29 ±0.18^{b}	9.63 ±0.30^{a}
Yolk height(cm)	1.67± 0.10^{a}	1.01 ±0.07^{c}	1.33 ±0.07^{b}	1.64 ±0.07^{a}	0.67 ±0.11^{d}
Yolk width (cm)	3.75 ±0.19^{c}	4.78 ±0.13^{b}	3.98 ±0.13^{c}	3.93 ±0.13^{c}	6.09 ±0.21^{a}
Shape index (%)	74.86 ± 1.37^{a}	77.18 ±0.96^{a}	77.82 ±0.96^{a}	76.11±0.96^{a}	77.03±1.36^{a}
Yolk index (%)	44.60 ±3.1^{a}	22.40 ±2.5^{b}	33.0 ±2.4 ^{ab}	41.6 ±2.22^{a}	14.72 ±4.21^{c}
Albumin index (%)	10.40 ±0.82^{a}	4.6 ±0.53^{b}	7.5 ±0.50^{ab}	9.5 ±0.54^{a}	3.1 ±0.94^{c}
Haugh unit (%)	83.37 ±8.8^{a}	56.5 ±6.0^{b}	69.31 ±6.32^{ab}	79.58 ±6.01^{a}	29.66 ±9.2^{c}

Table-2. External and internal egg quality traits as affected by storage time.

Egg quality traits	**Storage time** (days)				
	Fresh egg (0)	**7**	**14**	**21**	**28**
Egg weight (g)	58.37 ± 1.43^{a}	54.34 ±1.01^{b}	51.84 ±1.01^{b}	51.47 ±1.18^{b}	51.22 ±1.17^{b}
Egg width (cm)	4.26 ±0.07^{a}	4.36 ±0.05^{a}	4.33 ±0.03^{a}	4.30 ±0.05^{a}	4.35 ±0.06^{a}
Egg length (cm)	5.70± 0.09^{a}	5.72 ±0.70^{a}	5.59 ±0.07^{a}	5.58 ±0.08^{a}	5.63 ±0.09^{a}
Albumin height (cm)	0.73 ±0.04^{a}	0.51 ±0.03^{b}	0.41 ±0.03^{b}	0.38 ±0.03^{bc}	0.29 ±0.03^{c}
Albumin width (cm)	7.02 ±0.26^{b}	7.93 ±0.18^{b}	8.55 ±0.20^{a}	8.87 ±0.21^{a}	8.96 ±0.21^{a}
Yolk height(cm)	1.67± 0.10^{a}	1.32 ±0.07^{b}	1.14 ±0.07^{b}	1.10 ±0.08^{b}	0.97 ±0.08^{b}
Yolk width (cm)	3.75 ±0.19^{b}	4.20 ±0.13^{ab}	4.81 ±0.14^{a}	4.94 ±0.15^{a}	5.44 ±0.15^{a}
Shape index (%)	74.86 ± 1.37^{a}	77.60 ±0.96^{a}	78.21 ±0.96^{a}	75.64 ±1.11^{a}	76.10 ±1.11^{a}
Yolk index (%)	44.6 ±3.1^{a}	32.5 ±3.0^{b}	25.2±3.0^{c}	21.8 ±3.0^{c}	17.3 ±3.0^{c}
Albumin index (%)	10.40 ±0.82^{a}	8.60 ±0.60^{ab}	5.0 ±0.60^{b}	4.2 ±0.70^{b}	3.6 ±0.70^{b}
Haugh unit (%)	83.37 ±8.8^{a}	63.0 ±5.0^{ab}	50.6 ±6.0^{b}	41.0 ±6.0^{b}	34.0 ±6.0^{c}

^{a,b,c} means within rows with different superscript are significantly ($P<0.05$) different from each other

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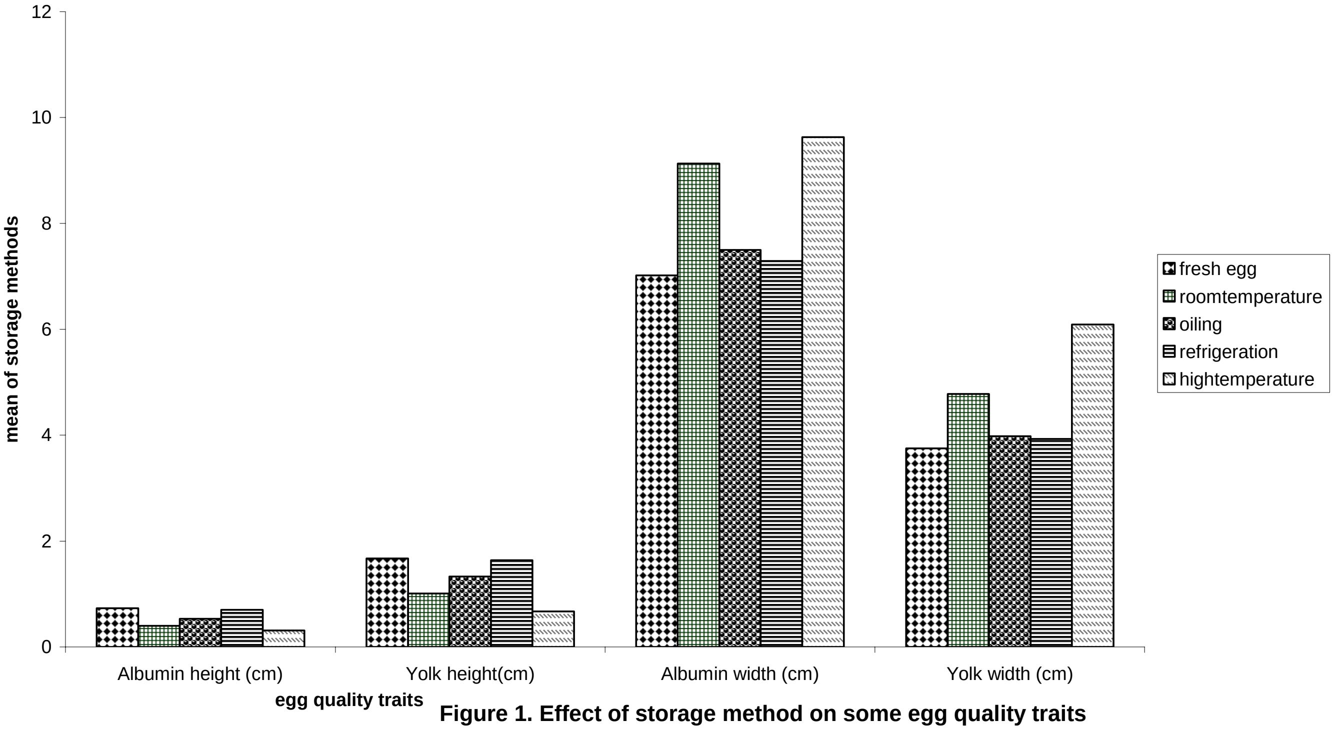

Figure 1. Effect of storage method on some egg quality traits

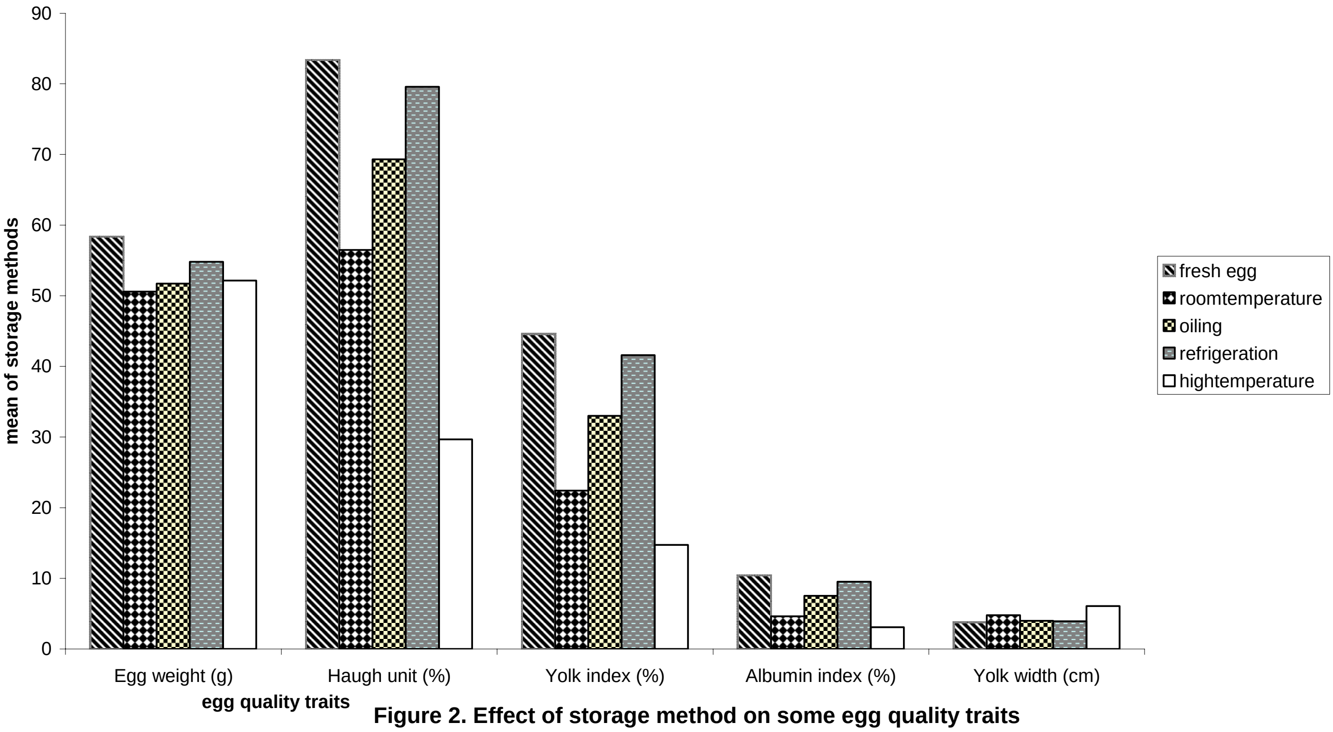

Figure 2. Effect of storage method on some egg quality traits

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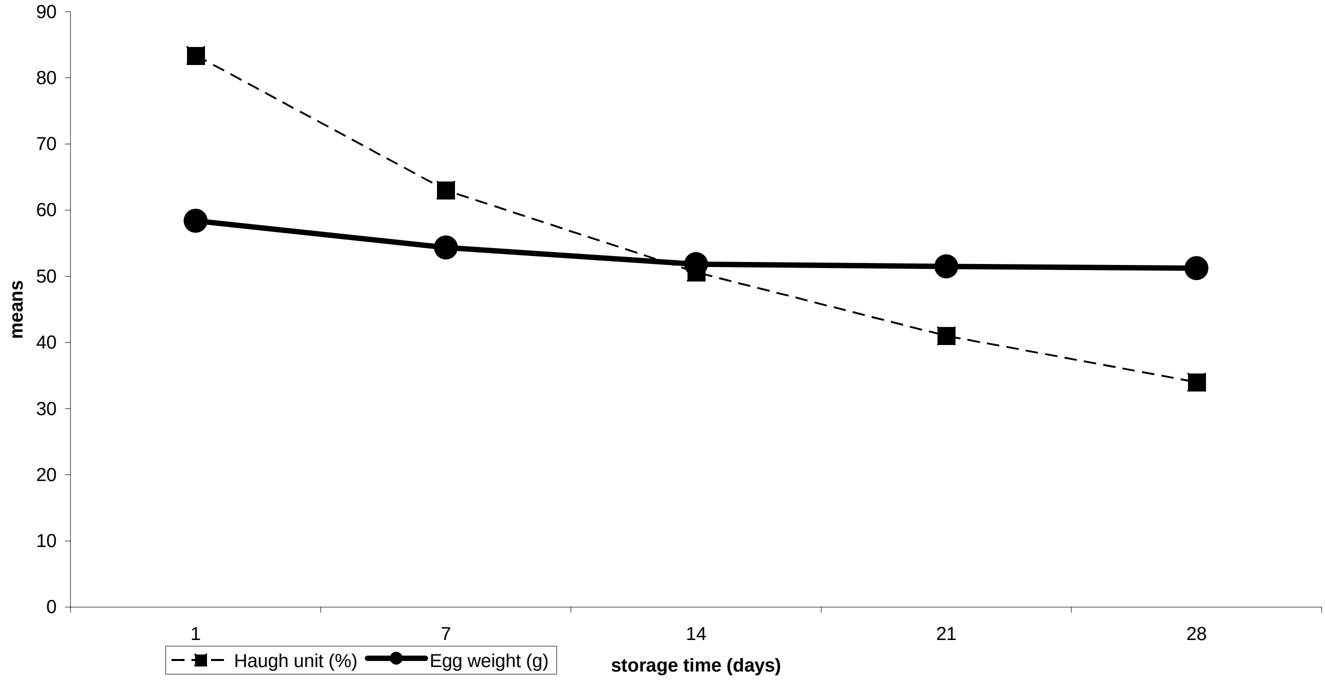

Figure 3. Effect of storage time on egg weight (g) and Haugh unit(%)

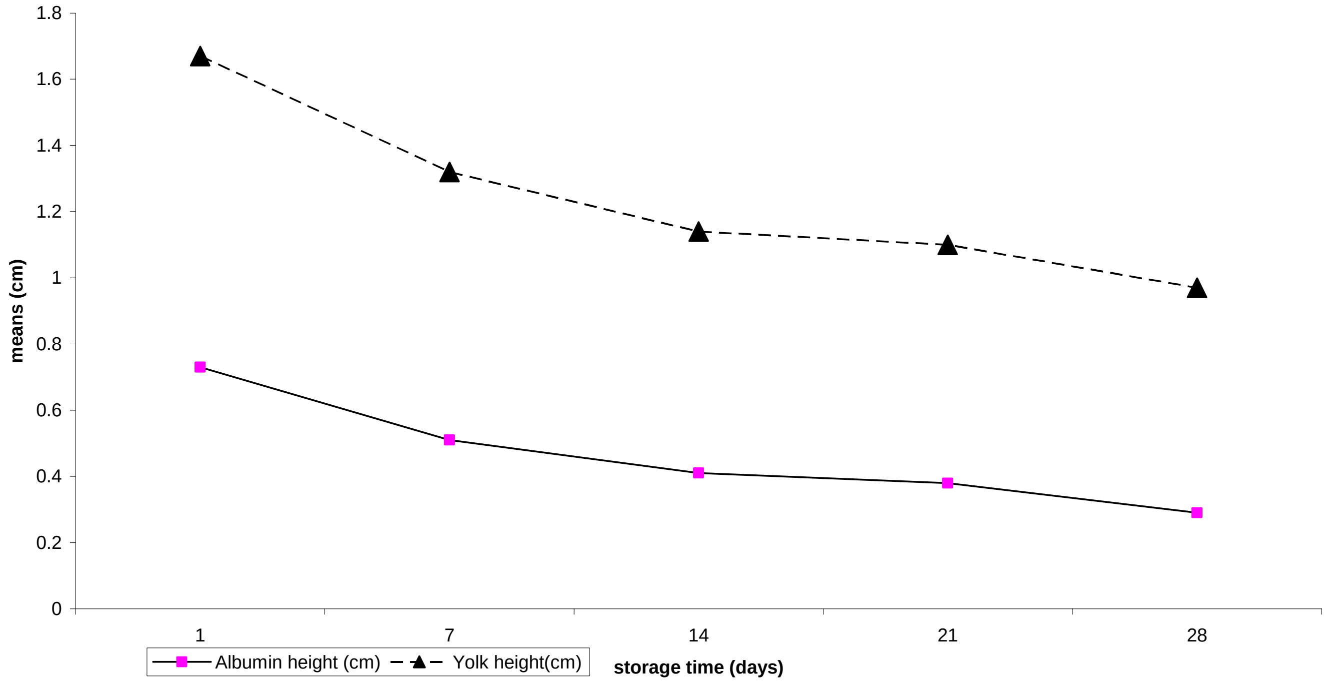

Figure 4. Effect of storage time on albumen and yolk width (cm)

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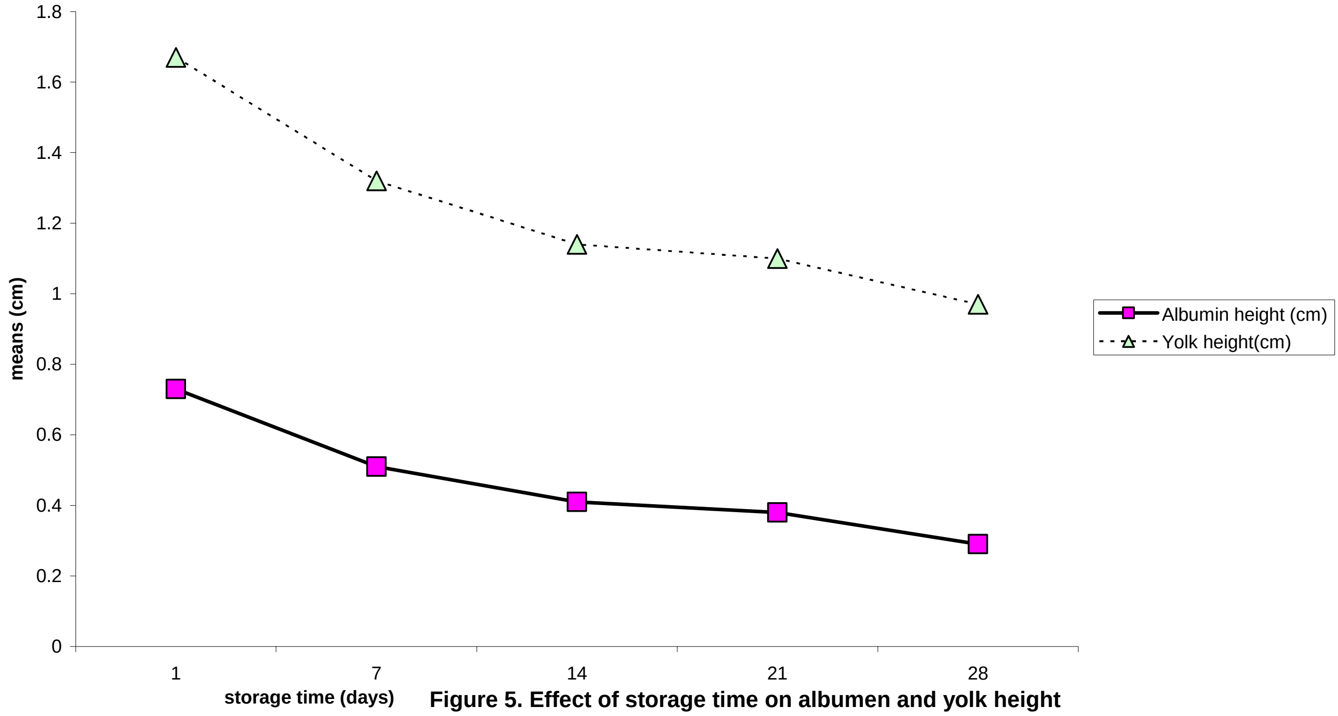

Figure 5. Effect of storage time on albumen and yolk height