EFFECT OF STORAGE CONDITIONS ON THE DYNAMICS OF TABLE EGGS PHYSICAL TRAITS

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Abstract

The research focused on the influence exerted by the storage conditions of table eggs on their physical quality traits. Four groups of eggs were set up (150 eggs/group), submitted to storage throughout 40 days, under different microclimate parameters (Lc=4°C and 90% relative moisture-RM; L-1=10°C and 80% RM; L-2 =15°C and 70% RM; L-3=25-30°C and 45% RM). At the end of the storage period, the lowest proportions of physical parameters depreciations were observed after refrigeration (Lc group) (1.11% for the weight; 1.17% for the specific gravity; 4.61% for the albumen index; 7.88% for the yolk index and 3.95% for the Haugh index. In the other groups, which simulated the storage conditions used by eggs marketers, freshness lost was directly proportional with the provided parameters values; thus, after 40 days of storage, the physical traits presented lower values, compared to the fresh eggs: 1.91-4.49% for the weight, 1.98-4.45% for the specific gravity, 14.13-49.91% for the albumen index, 19.86-50.9% lower for the yolk index and 12.84-26.59% for the Haugh index. The achieved results certify that the storage of table eggs must be carried under refrigeration conditions, at +4°C and 90% relative moisture.

Key words: eggs, quality, storage, conditions

INTRODUCTION

The eggs are perishable products, whose original quality is affected in time by many various factors [5, 8], among we could specify storage conditions [2, 4, 7].

In certain conjunctures, the table eggs must be stored longtime [5], but there are also situations in which their keeping for selling is done totally inadequate and throughout time lengths which are passing the legal validity period [7].

In both situations, gradual depreciation of the physical traits defining eggs quality could be observed then of those related to the nutritional and safety quality [1, 8].

However, the most dangerous situation could occur during long storage periods (especially when inappropriate conditions are provided) because of the exponential development of the contaminating microorganisms, which could generate alterative phenomenon [3], with severe consequences on the consumers health status [6].

MATERIAL AND METHODS

The research has been carried on 600 commercial eggs, sorted as weight and shape (to eliminate the influence of any other factors than those proposed to be studied) and randomly allocated in 4 groups: a control group (Lc) and 3 experimental groups (L-1, L-2 and L-3); the experimental variables consisted in the microclimate factors provided during eggs storage (tab. 1).

Table 1 Experimental design

Group	Eggs	Temperature (°C)	Air moisture (%)
Lc	150	+4	90
L-1	150	+10	80
L-2	150	+15	70
L-3	150	+25 ÷ +30	45

Just the physical traits of the eggs have been supervised in dynamics, mainly those whom levels are directly and rapidlu affected by the storage conditions provided (weight;

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specific gravity; albumen index; yolk index; Haugh index).

Standardized methods were used in assessing quality parameters (weighing; height and diameter measurements, saline solutions) as well as the Egg Analyzer device for the Haugh index.

The quality was assessed on fresh eggs, (day 0), then at every 10 days, till the 40th storage day, inclusively.

RESULTS AND DISCUSSIONS

1. Eggs weight. Normal weight loss during refrigeration should reach 0.7-1.0%/month, if air humidity is provided at 90%.

Severe sorting of the eggs in the 4 groups led to slam differences at the beginning of storage, 57.69-57.72 g with a quite reduced variability (V%=1.34-2.65).

The provided microclimate conditions throughout the 40 storage days influenced in different manners their weight dynamics (tab. 2).

Table 2 Eggs weight (n=150)

Eggs age (days)	Group	Statistics	
		$\bar{X} \pm s_{\bar{X}}$ (g)	V%
0	Lc	57.71±0.12	2.65
	L-1	57.72±0.06	1.34
	L-2	57.69±0.07	1.59
	L-3	57.70±0.09	1.97
10	Lc	57.57±0.20	4.22
	L-1	57.39±0.23	4.81
	L-2	57.09±0.21	4.57
	L-3	56.63±0.22	4.74
20	Lc	57.48±0.28	5.99
	L-1	57.16±0.29	6.29
	L-2	56.86±0.70	15.17
	L-3	56.24±0.82	17.82
30	Lc	57.30±0.39	8.28
	L-1	56.99±0.50	10.75
	L-2	56.50±0.91	19.65
	L-3	55.94±0.97	21.22
40	Lc	57.07±0.43	9.28
	L-1	56.62±0.58	12.52
	L-2	56.21±1.02	22.31
	L-3	55.11±1.08	24.01

Thus, less weight decrease (from 57.71±0.12 g in fresh eggs till 57.07±0.43 g in 40 days old ones) were observed in Lc eggs (storage at +4°C and 90% R.H.), while more were noticed in L-3 group (57.70±0.09g-fresh eggs and 55.11±1.08g-40 days eggs) (storage at +25…+30°C and 40% R.H.), which meant 1.11%, respectively 4.49% weight loss.

In L-1 group (stored at +10°C and 80% R.H.) weight loss reached 1.91% (from 57.72±0.06g-fresh ones to 56.62±0.58g-40 days old ones), while in group L-2 (storage at +15°C and 70% R.H.) there were 2.55% looses (from 57.69±0.07g-fresh eggs, to 56.21±1.02g- 40 days stored eggs).

Although water loss is related to by the amount and size of shell pores, this was mostly influenced by the provided microclimate factors, while in Lc was achieved the best homogeneity (V%=2.65-9.28), compared to L-1 group (V%=1.34-12.52), L-2 group (V%=1.59-22.31) and especially with that in group L-3 (V%=1.97-24.01).

2. Specific gravity. In fresh eggs, it reaches 1.078-1.097 g/cm^3 and decreases at 1.040-1.059 g/cm^3 after one month storage at +4°C, basing on water content loss.

Within this experiment, Lc eggs presented initial specific gravity of 1.0822±0.002g/cm^3 and of 1.0695±0.008g/cm^3 after 40 days, representing a percent reduction of 1.17%.

In L-1 eggs, the decrease of specific gravity was of 1.98% (from 1.0823±0.002 g/cm^3-fresh eggs, to 1.0695±0.008 g/cm^3-40 days stored eggs), while those in L-2 group lost 2.61% (from 1.0824±0.002 g/cm^3 to 1.0542±0.016 g/cm^3).

The most relevant decreases of specific gravity were observed in the eggs from L-3 group (from 1.0823±0.001 g/cm^3, to 1.0341±0.018 g/cm^3), which represented 4.45% loss.

In control group, the analyzed trait presented well homogeneity, throughout the entire storage period (V%=1.78-9.17), while in the experimental groups, the variability was average or even higher in those older than 40 days (V%=13.84-21.56) (tab. 3).

Table 3 Specific gravity (n=150)

Eggs age (days)	Group	Statistics	
		$\bar{X} \pm s_{\bar{x}}$ (g/cm^3)	V%
0	Lc	1.0822±0.002	1.78
	L-1	1.0823±0.002	1.96
	L-2	1.0824±0.002	1.75
	L-3	1.0823±0.001	1.64
10	Lc	1.0796±0.005	5.22
	L-1	1.0772±0.005	5.37
	L-2	1.0730±0.005	5.61
	L-3	1.0621±0.004	5.17
20	Lc	1.0768±0.006	6.47
	L-1	1.0714±0.007	8.21
	L-2	1.0667±0.008	8.99
	L-3	1.0546±0.009	10.58
30	Lc	1.0725±0.006	7.17
	L-1	1.0665±0.009	10.63
	L-2	1.0598±0.011	13.08
	L-3	1.0497±0.015	17.58
40	Lc	1.0695±0.008	9.17
	L-1	1.0609±0.012	13.84
	L-2	1.0542±0.016	18.08
	L-3	1.0341±0.018	21.56

3. Albumen index. Among the eggs compounds, the one suffering the most qualitative degradation during storage is the egg white (albumen). Normally, the fresh eggs must have an albumen index of 0.106, while the old ones could decrease till 0.032.

In the eggs kept under refrigeration conditions (Lc group), the albumen index was of 0.1063±0.0004 in the fresh ones and of 0.1014±0.0016 in those stored during 40 days, while the variability was quite low for the analyzed trait (V%=2.38-11.38).

When the eggs were stored at +10^{o}C and humidity of 80% (L-1 group), albumen index decreased from 0.1061±0.0004 (fresh eggs), la 0.0911±0.0016 (eggs aged 40 days), while in those stored at +15^{o}C and humidity of 70% (group L-2), from 0.1062±0.0004 (fresh eggs), to 0.0729±0.0015 (eggs stored 40 days). The highest decrease of albumen index (from 0.1060±0.0004 to 0.0531±0.0016) was noticed in the eggs stored at +25 ÷ +30^{o}C and 45% relative humidity (L-3 group).

In the 3 experimental groups (L-1, L-2 and L-3), the variability of the trait was quite low during storage beginning (V%=2.69-2.97), then it lost its homogeneity till the end of storage (40th) presenting middle or high variability (V%=12.71-21.83) (tab. 4).

Table 4 Albumen index (n=50)

Eggs age (zile)	Group	Statistics	
		$\bar{X} \pm s_{\bar{x}}$	V%
0	Lc	0.1063±0.0004	2.38
	L-1	0.1061±0.0004	2.69
	L-2	0.1062±0.0004	2.97
	L-3	0.1060±0.0004	2.76
10	Lc	0.1057±0.0011	7.22
	L-1	0.1050±0.0012	8.12
	L-2	0.1002±0.0012	8.66
	L-3	0.0954±0.0013	9.58
20	Lc	0.1050±0.0015	9.80
	L-1	0.1022±0.0015	10.12
	L-2	0.0912±0.0015	11.43
	L-3	0.0732±0.0014	13.08
30	Lc	0.1039±0.0016	10.69
	L-1	0.0975±0.0016	11.58
	L-2	0.0806±0.0014	12.67
	L-3	0.0633±0.0016	17.98
40	Lc	0.1014±0.0016	11.38
	L-1	0.0911±0.0016	12.71
	L-2	0.0729±0.0015	14.96
	L-3	0.0531±0.0016	21.83

4. Yolk index. In fresh eggs, this quality trait has values of 0.442-0.361 in fresh eggs, or of 0.300-0.250 in the old ones.

In aged eggs, the vittelin membrane resistance decreases (yolk is flattening), with the risk of breakage in forced movements.

In fresh eggs, yolk index presented very close values between groups (0.0443-0.0444) and good homogeneity (V%=2.13-2.64).

During storage, the provided conditions induced yolk index decrease thus at the end of the experiment (40th day) there were found levels of 0.0409±0.0004 in Lc eggs, of 0.0355±0.0006 in L-1 eggs, of 0.0288±0.0005 in L-2 eggs and of 0.0218±0.0006 in L-3 eggs.

Speaking of homogeneity, proper values were found in control group (V%=9.87), while average to high variability was found in the experimental ones (V%=11.69-20.22) (tab. 5).

Table 5 Yolk index (n=50)

Eggs age (days)	Group	Statistics	
		$\bar{X} \pm s_{\bar{x}}$	V%
0	Lc	0.0444±0.0001	2.13
	L-1	0.0443±0.0002	2.47
	L-2	0.0443±0.0002	2.52
	L-3	0.0444±0.0002	2.64
10	Lc	0.0441±0.0004	6.81
	L-1	0.0437±0.0005	7.54
	L-2	0.0416±0.0005	7.69
	L-3	0.0397±0.0005	8.02
20	Lc	0.0436±0.0005	7.87
	L-1	0.0418±0.0005	8.11
	L-2	0.0376±0.0005	9.03
	L-3	0.0303±0.0005	11.45
30	Lc	0.0425±0.0005	8.39
	L-1	0.0391±0.0005	9.58
	L-2	0.0328±0.0005	9.90
	L-3	0.0258±0.0005	14.41
40	Lc	0.0409±0.0004	9.87
	L-1	0.0355±0.0006	11.69
	L-2	0.0288±0.0005	12.12
	L-3	0.0218±0.0006	20.22

5. Haugh index. This quality parameters, despite its large usage in incubation assessments, became more and more frequent applied in described the table eggs quality, knowing it is calculated on the dense albumen height and on eggs weight, traits correlated with eggs freshness degree.

Close values were found at the beginning of the experiment, between the four groups, with variation limits between 84.93±0.43 HU (L-2) and 85.06±0.43 HU (L-3); homogeneity of this trait was very good (V%=3.04-3.91).

Subsequently, basing of weight looses and on albumen viscosity reduction, progressive decrease of Haugh units was observed, reaching, by the end of the experiment, levels of 81.62±1.17 HU in Lc eggs, of 74.11±1.47 HU in L-1 eggs, of 66.24±1.80 HU in L-2 eggs and of just 62.44±2.07 HU in L-3; the studied trait was also homogenous in control group (V%=10,10) and heterogeneous in the experimental ones (V%=14.05-23.45) (tab. 6).

Table 6 Haugh index (n=50)

Eggs age (days)	Group	Statistics	
		$\bar{X} \pm s_{\bar{x}}$	V%
0	Lc	84.98±0.47	3.91
	L-1	85.03±0.36	3.04
	L-2	84.93±0.43	3.59
	L-3	85.06±0.43	3.67
10	Lc	84.11±0.52	4.41
	L-1	81.88±0.65	5.66
	L-2	79.24±0.63	6.93
	L-3	79.01±0.79	7.03
20	Lc	83.09±0.77	6.56
	L-1	78.89±1.00	8.99
	L-2	74.41±1.06	10.11
	L-3	73.28±1.34	12.92
30	Lc	82.03±1.08	9.28
	L-1	77.67±1.48	13.45
	L-2	70.28±1.44	14.51
	L-3	67.46±1.67	17.47
40	Lc	81.62±1.17	10.10
	L-1	74.11±1.47	14.05
	L-2	66.24±1.80	19.21
	L-3	62.44±2.07	23.45

CONCLUSIONS

The acquired data on the dynamics of the physical parameters of the table eggs stored under different conditions led to the following conclusions:

- Weight loss reached 1.11% only in the refrigerated eggs, compared to 1.91-4.49% in those preserved under the same temperature and moisture conditions as the eggs marketers usually do. The same situation occurred for the specific gravity (1.17% in refrigerated eggs and 1.98-4.45% in the experimental groups);
- Albumen quality, assessed through albumen index and Haugh index, preserved within better interval in the eggs stored 40 days through refrigeration (decrease of just 4.61% and of 3.95%), comparing with the results occurred in the eggs stored under commercial conditions (looses of 14.13-49.91% and of 12.94-26.59%);
- Yolk index was less influenced by the physical microclimate parameters provided to the control group (decrease of 7.88%, compared to the fresh eggs), while in the experimental groups, the

temperature levels associated with lower air humidity values led to decreases of 19.86-50.90%, compared to the initial measured values.

These results allow us to state that the table eggs must be stored only under refrigeration conditions, at +4^{o}C temperature and a relative air humidity of 90%.

Using of other storage conditions (a common practice in the food stores for certain food commodities, such eggs), leads without any doubt to the loss of the physical quality parameters of the table eggs and of course, of their nutritional and safety values.

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