EFFECTS OF TEMPERATURE AND STORAGE TIME ON HEN EGGS QUALITY

Roxana Gavril, M.G. Usturoi

University of Agricultural Sciences and Veterinary Medicine „Ion Ionescu de la Brad" Iaşi
e-mail: roxuletzu11@yahoo.com

Abstract

The research focused on studying the way in which the level of ambiental factors assured during egg storage influence their quality. Biologic material was represented by 180 hen eggs, divided in tow batches and stored for 35 days in different conditions of microclimate (batch L1 temperature 25±1ºC and relative noisture 45%; batch L2 temperature = 4±1ºC and relative noisture = 84%). Evaluation of eggs quality was realised through some physical indexes, determinated at each 7 days of storage, in according with the clasical techinques of appreciations. Even, at the begining of storage, the eggs from the 2 beatches presented close qualitative indexes, on storage time passing. We found a decrese of the values, especially at the eggs storaged in the same conditions with the ouns from same sellers. From exemple, at the abave mentioned batch (L1), the decrese of quality indexes was more rapid, the recorded levels being higher with 5.54% for eggs`weight losses repectively lower with 51.35% for albumen index, with 32.0% for yolk index and with 52.53% for Haugh index, in comparasion with the values recorded at the eggs stored in according with the standards (L2). The obtained data show the fact that without assurement of some optim condition during eggs` storage affect their quality even at a storage on a verry shourt period of time.

Key words: eggs, consume, storage, microclimate, quality

INTRODUCTION

Eggs represents an important source of energy, proteins, and other beneficial substances for human body [3]; the low caloric value, good digestibility of the components and the great content in nutrients made egg an important foodstuff for many dietary regimes [6].

Eggs are considered to be a perishable foodstuff, due to the low efficiency of their natural protection barriers, when eggs are stored for a long period of time and especially in inappropriate conditions, their initial quality goes impaired, becoming, even, not good for consumption [1].

Taking all of these into account in the present study we propose to determine the influence degree of microclimate factors assured during storage on some physical quality indicators specific to consumption eggs.

MATERIAL AND METHOD

The studied material was represented by 180 hen eggs, uniform from the initial weight point of view; which were divided in two equal batches (L1 and L2), but differentiated through the value of microclimate factors assured during storage *(tab. 1)*

Table 1. Organization of experience

Batch	Eggs number	Storage period (days)	Temperature (ºC)	Relative humidity (%)
L1	90	35	25±1	45
L2	90	35	4±1	84

Quality indexes of eggs were determine at each 7 days, starting with the first storage day till day 35, respectively, in according with the appreciation techniques used in aviculture:

- *weight* was established by individual weighting of each egg, using an analytical balance;
- *specific gravity* was determined through saline solutions method, using 11 pots with saline solutions of the same temperature, but with different densities. The analysed egg is passing, one time each, from a pot to another, being well drained from the previous solution; the pot in which the egg

rise to the surface show the specific gravity, by its solutions; density;

- *albumen index* was calculated based on the ration between height and diameter of the egg; albumen height was determined with a device with a comparative watch, and the diameter was measured with an electronic caliper;
- *yolk index* is provided by the ratio between diameter and height, these dimensions were measured with the same equipments as at albumen and using a same working method;
- *Haugh index* characterize the total value of egg quality and is based on the correlation between dense albumen height and egg weight; the concretion of this index was realised using some specific relations.

The obtained experimental date was statistical processed with the help of ANOVA unifactorial algorithm, obtaining the main statistical estimators and the significance of the differences between the calculated means.

RESULTS AND DISCUSSIONS

1. Egg weight. As it was mentioned above the studied eggs were sorted by weight, aspect put in light by the absence of statistical differences between batches at the control realised in the first day of storage (fresh eggs). So the mean values established for eggs weight were of 64.13±0.332g at batch L1 (with a minimum of 60.05g and a maximum of 65.86g) and respectively, of 63.91±0.263g at batch L2 (minimum = 60.57g; maximum = 65.83g); the studied character was also very homogenous, the calculated values for variability coefficient being of 2.31% respectively of 1.84%.

The assured microclimate factors was involved in the evaporation rhythm of the water from eggs, so after 7 days of storage appeared significant statistical differences between the two batches, due to the mean weight of only 62.67±0.352 g at batch L1 and of 63.50±0.267g at batch L2.

Consecutively eggs aging, the weight differences between the two batches increased, so at the control made after 35 days of storage were recorded mean values of 58.39±0.457g at the eggs from batch L1 and of 61.73±0.283g at the ones from batch L2, resulting the appearance of very significant statistical differences between batches *(tab 2).*

Table 2. Evolution of weight (g) of the studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$ (g)	V%	Minimum (g)	Maximum (g)
1	L1	90	64.13±0.332	2.31	60.05	65.86
	L2	90	63.91±0.263	1.84	60.57	65.83
7	L1	90	62.67±0.352^{b}	2.51	58.38	64.44
	L2	90	63.50±0.267^{a}	1.87	60.19	65.51
14	L1	90	61.84±0.371^{b}	2.68	57.43	63.87
	L2	90	63.05±0.268^{a}	1.90	59.78	65.13
21	L1	90	60.95±0.363^{c}	2.66	56.79	62.83
	L2	90	62.69±0.273^{a}	1.94	59.40	64.81
28	L1	90	59.60±0.417^{c}	3.12	55.44	62.00
	L2	90	62.20±0.278^{a}	1.99	58.89	64.48
35	L1	90	58.39±0.457^{d}	3.49	53.92	61.33
	L2	90	61.73±0.283^{a}	2.05	58.30	63.97

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:

Without exponent = insignificant differences between means

ab = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;178 GL.

ac = distinct significant differences, $\hat{F} > F_{\alpha}(0.01)$ at 1;178 GL.

ad = very significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;178 GL.

2. Weight losses. Normally the eggs stored for longer periods of time losses from their initial weight about 0.7 – 1%/month, due to the evaporation of the water from their content [1].

In our study, the weight losses of the eggs were greater than the normal ones and with distinct and very significant statistical differences between batches, function of the level in which were assured the storage factors. For example, at the eggs from batch L1, weekly losses in weight of the eggs were between 1.32±0.0035% (period 8-14 days) and 2.28±0.0056% (interval 1-7 days), while at batch L2, oscillation limits were between 0.57±0.0012% (period 15-21 days) and 0.78±0.0020% (period 22-28 days). On all storage period, the eggs' losses in weight were situated at a level of 8.95% at batch L1 and of only 3.41% at batch L2. The studied character was homogenous on control stages, the calculated values for variation coefficient being of 1.81-4.03% (tab. 3).

Table 3. Evolution of weight losses (%) at the studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$ (%)	V%	Minimum (%)	Maximum (%)
1-7	L1	90	2.28±0.0056^{d}	2.32	2.26	2.31
	L2	90	0.64±0.0012^{a}	1.81	0.62	0.67
8-14	L1	90	1.32±0.0035^{c}	2.53	1.30	1.35
	L2	90	0.70±0.0014^{a}	1.96	0.67	0.73
15-21	L1	90	1.44±0.0045^{c}	2.97	1.41	1.46
	L2	90	0.57±0.0012^{a}	2.03	0.55	0.59
22-28	L1	90	2.21±0.0087^{d}	3.76	2.18	2.23
	L2	90	0.78±0.0020^{a}	2.49	0.76	0.81
29-35	L1	90	2.03±0.0086^{d}	4.03	2.01	2.05
	L2	90	0.76±0.0042^{a}	3.25	0.74	0.79

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:

Without exponent = insignificant differences between means

ab = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;178 GL.

ac = distinct significant differences, $\hat{F} > F_{\alpha}(0.01)$ at 1;178 GL.

ad = very significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;178 GL.

3. Specific gravity. At fresh eggs, this quality indicator is of 1.078-1.097, but decrease till the levels of 1.040-1.059 at old eggs [5].

The obtained data showed a progressive decreasing of the values which characterised the eggs specific gravity, in correlation with the level of the assured physical parameters at storage. So at batch L1, the specific gravity of eggs was of 1.081±0.0028 in the first day of storage and of only 1.059±0.0052 at the end of storage period (day 35), while at batch L2, the determinate values were of 1.082±0.0149 at the beginning of storage period and of 1.062±0.0163 at the end of it. Between the two batches were identified significant statistical differences at the controls made in day 7 and 14 of storage, distinct significant in day 21 and 28, and respectively, very significant differences at the control from day 35. The studied character was homogenous inside each batch and at each stage of control, the calculated values for variability coefficient being of 1.44-2.39% at batch L1 and a little bit more greater at batch L2, 7.16-7.66 *(tab. 4).*

Table 4. Evolution of specific gravity at studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$	V%	Minimum	Maximum
1	L1	90	1.081±0.0028	1.44	1.080	1.084
	L2	90	1.082±0.0149	7.16	1.080	1.085
7	L1	90	1.076±0.0032[b]	1.49	1.074	1.078
	L2	90	1.081±0.0151[a]	7.31	1.079	1.081
14	L1	90	1.074±0.0030[b]	1.60	1.072	1.078
	L2	90	1.078±0.0156[a]	7.50	1.075	1.080
21	L1	90	1.074±0.0331[c]	1.59	1.071	1.076
	L2	90	1.077±0.0161[a]	7.38	1.075	1.080
28	L1	90	1.062±0.0042[c]	1.98	1.059	1.065
	L2	90	1.068±0.0162[a]	7.63	1.065	1.070
35	L1	90	1.059±0.0052[d]	2.39	1.056	1.062
	L2	90	1.062±0.0163[a]	7.66	1.058	1.064

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:
Without exponent = insignificant differences between means
ab = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;178 GL.
ac = distinct significant differences, $\hat{F} > F_{\alpha}(0.01)$ at 1;178 GL.
ad = very significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;178 GL.

4. Albumen index. Dimensional appreciation of albumen could offer information regarding freshness state of eggs, this quality index presents values of 0.106 at fresh eggs and 0.039 at the old ones and of only 0.032 at very old ones [4].

If at the beginning of the storage period, albumen index was close between the two batches (0.107±0.0011 at batch L1 and 0.106±0.0011 at batch L2), after that we observe a decreasing evolution, sharpest at the eggs stored at high temperatures. So in day 7 respectively in day 14 of storage between batches were identified significant statistical differences, at the controls from day 21 and day 28 the recorded statistical differences were distinct significant, and at the end of experiment (day 35), statistical differences between batches are very significant, based on values of 0.056±0.0027 at batch L2 and of only 0.037±0.0034 at batch L1.

Concretion of variability coefficients for the studied character showed a certain homogenous at the beginning of storage, after that became more and more less uniform both for eggs of batch L1 (V%=6.73-29.31), respectively at batch L2 (V%=6.75-24.58) *(tab. 5).*

Table 5. Evolution of albumen index at the studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$	V%	Minimum	Maximum
1	L1	10	0.107±0.0011	6.73	0.105	0.109
	L2	10	0.106±0.0012	6.75	0.104	0.108
7	L1	10	0.087±0.0013[b]	9.56	0.085	0.089
	L2	10	0.102±0.0014[a]	8.66	0.100	0.105
14	L1	10	0.074±0.0015[b]	12.93	0.072	0.075
	L2	10	0.093±0.0016[a]	9.33	0.091	0.095
21	L1	10	0.053±0.0020[c]	19.46	0.051	0.055
	L2	10	0.079±0.0011[a]	11.23	0.077	0.081
28	L1	10	0.042±0.0029[c]	25.31	0.040	0.045
	L2	10	0.068±0.0034[a]	18.41	0.066	0.070
35	L1	10	0.037±0.0034[d]	29.31	0.035	0.039
	L2	10	0.056±0.0027[a]	24.58	0.054	0.058

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:
Without exponent = insignificant differences between means
ab = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;18 GL.
ac = distinct significant differences, $\hat{F} > F_{\alpha}(0.01)$ at 1;18 GL.
ad = very significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;18 GL.

5. Yolk index. This indicator permits the appreciation of eggs quality through the state of yolk membrane, which assures the integrity and the shape of yolk; during eggs aging, yolk membrane is weakly and show a wrinkled appearance, determining the flattening of yolk and in this way the decreasing of the values for yolk index [6].

The above mentioned phenomenon was valid for both batches of eggs stored for 35 days, with the mention that was more obvious at the ones kept at temperatures of +25 ^{0}C. The calculated values for yolk index were between 0.044±0.0001 (first day of storage) and 0.025±0.0011 (day 35) at batch L1 and respectively, between 0.044±0.0001 (first day) and 0.033±0.0002 (day 35) at batch L2. In these conditions, between the two batches were identified statistical differences, significant type in days 7 and 14 of storage, distinct significant in days 21 and 28 of storage and respectively very significant in the 35 day of storage.

Variation coefficient presented values specific to a low variability to an average one, both in the case of the effectuated analyse for batch L1 (V%=1.97-15.36), as also for the one for batch L2 (V%=1.73-12.24) *(tab. 6).*

Table 6. Evolution of yolk index at the studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$	V%	Minimum	Maximum
1	L1	10	0.044±0.0001	1.97	0.042	0.046
	L2	10	0.044±0.0001	1.73	0.042	0.046
7	L1	10	0.040±0.0002^b	3.76	0.038	0.042
	L2	10	0.042±0.0001^a	2.09	0.038	0.044
14	L1	10	0.036±0.0005^b	7.34	0.034	0.038
	L2	10	0.039±0.0003^a	4.98	0.036	0.041
21	L1	10	0.031±0.0007^c	9.21	0.029	0.034
	L2	10	0.037±0.0004^a	5.12	0.35	0.039
28	L1	10	0.028±0.0010^c	11.12	0.026	0.030
	L2	10	0.036±0.0011^a	8.16	0.034	0.038
35	L1	10	0.025±0.0011^d	15.36	0.023	0.027
	L2	10	0.033±0.0002^a	12.24	0.031	0.036

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:

Without exponent = insignificant differences between means

ab = significant differences, $\hat{F} > F_\alpha(0.05)$ at 1;18 GL.

ac = distinct significant differences, $\hat{F} > F_\alpha(0.01)$ at 1;18 GL.

ad = very significant differences, $\hat{F} > F_\alpha(0.001)$ at 1;18 GL.

6. Haugh index. It is used, especially, to appreciate the eggs for incubation, but it is also suitable for consumption eggs, because defined the total value of quality, based on dense albumen index and eggs weight [2].

As in the case of the previous quality indexes studied by us, the differences between the two batches were insignificant at the beginning of storage period, the determine values being of 87.43±1.082 UH at batch L1 (minimum of 85.26 UH and maximum of 89.15 UH) and by 88.91±1.083 UH at batch L2 (minimum of 86.32 UH and maximum of 89.54 UH).

Changes occurring in eggs weight and in dense yolk consistency lead to a gradual decrease of the values of Haugh index, especially at batch L1, fact which determine the apparition of significant statistical differences between batches, and later distinct and very significant. The highest differences between batches were recorded at the end of storage period, the values calculated for Haugh index being of only 44.11±1.402 UH at batch L1 and of 67.28±1.825 UH at batch L2.

The studied character was very homogenous (V%=2.58-8.15), with the exception of the last two control periods from batch L1, when we calculate the following indexes (V%=12.47-14.32) which show a mean variability *(tab. 7).*

Table 7. Evolution of Haugh index at the studied eggs

Storage period (days)	Experimental batch	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{x}}$ (U.H)	V%	Minimum (U.H)	Maximum (U.H)
1	L1	10	87.43±1.082	2.77	85.26	89.15
	L2	10	88.91±1.083	2.58	86.32	89.54
7	L1	10	69.32±1.510[b]	4.18	66.62	71.12
	L2	10	80.13±1.003[a]	3.12	78.52	82.74
14	L1	10	64.75±2.069[b]	6.22	62.25	67.14
	L2	10	76.21±1.313[a]	4.47	74.87	77.12
21	L1	10	51.83±3.071[c]	7.32	49.89	53.55
	L2	10	75.62±1.861[a]	5.12	71.57	75.61
28	L1	10	48.45±3.071[c]	12.47	46.32	49.17
	L2	10	73.48±1.354[a]	6.87	73.71	77.41
35	L1	10	44.11±1.402[d]	14.32	42.25	46.87
	L2	10	67.28±1.825[a]	8.15	65.87	69.58

Statistical signification (ANOVA): exponents from the same column, for each batch and control day:

Without exponent = insignificant differences between means

ab = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;18 GL.

ac = distinct significant differences, $\hat{F} > F_{\alpha}(0.01)$ at 1;18 GL.

ad = very significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;18 GL.

CONCLUSIONS

Appreciation in dynamics of physical qualitative indicators at consumption eggs stored in different regimes of microclimate, show the following aspects:

- weight losses at the eggs stored in refrigeration conditions (batch L2) was of only 3.41%, face to 8.95% as was find at the ones kept at a temperature of +25 ^{0}C (batch L1);
- during storage period, specific gravity of eggs decreased with 2.03% at batch L1 and with only 1.84% at batch L2, in comparison with the specific levels of fresh eggs;
- at the end of storage period, the most significant differences face to the values establish at fresh eggs were found for albumen index (lower with 43.18% at batch L1 and with only 25.0% at batch L2);
- reducing of the eggs weight (due to the content water lose), but also the fluidization in time of albumen, leads to decreasing of Haugh index with only 24.33% in the case of the eggs from batch L2 and with 49.55% at the ones from batch L1.

The obtained results shows the fact that the storage of consumption eggs at a temperature of +4^{0}C and an air relative humidity of 84% assure a good stability in time for physical indexes which define the egg quality. In the same context we must pay attention on the effects exercised by the storing regimes used by some sellers on eggs quality, with rigorous impact on consumers health.

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