Contributions to the Knowledge of Qualitative Parameters for Egg Powder

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Abstract

The current paper is focused on the quality indexes of integral egg powder stored in different microclimate conditions. Failure of temperature and air moisture content leads to depreciation of egg powder quality in a more accelerated way than at eggs. From those reasons we aimed to study the evolution of qualitative parameters during storage in different environmental conditions.

For that, we constituted 3 batches were we have determine the sensorial characteristics of the product, solubility and pH value. In addition with those determinations were effectuated a series of chemical analysis, tracking water content which was determined by drying stove, dry matter (%) and content in mineral substances (mg/100g) which was determined through atomic absorption spectrometric method (AAS) with a GBC-AVANTA spectrophotometer type.

The first observed modifications, after sensorial control, were mentioned in the 90th day at batch Lexp-2 which presented modifications of aspect and consistency (instable agglomerations). Regarding pH value this one suffer modifications during those 180 days of storage, the recorded values at final being higher with 1.84% at batch Lc, 8.91% at batch Lexp-1 and with 10.38% at batch Lexp-2. Regarding the chemical content of analysed product, experimental factors influenced only water content respectively the dry matter content, determinations being made on mineral substances (Fe, Zn, Ca, Mg).

In conclusion we can say that the failure of pack type and of microclimate factors assured during storage leads to depreciation of the product in a quite short time.

Keywords: *quality, storage, packing*

INTRODUCTION

Eggs as well as egg products represent an important source of energy, proteins, and other nutritive substances necessary for humans, and their rationally consumption stimulates metabolic functions of organism and determine the increasing at illness; concomitantly, assure fortification and good function of nervous system (Sauveur, 1988).

Those are in the front of all sources of amino acids, no matter of their provenience (animal or vegetal), but are also an excellent source of vitamins and mineral substances, especially of digestible phosphorous and iron (Nys *et al.*, 2011).

Vitamins from eggs permit to fulfil human demands in rate of 5–100%, function of nutritional conditions which were assured for birds during exploitation period (Vancea, 1978); vitamins contained are resistant at cold (are not destroyed for 6 months at storage in refrigeration conditions), as well as at hot (are totally kept at egg boiling till 15–20 minute) (Seuss-Baum, 2007).

All of those demonstrate the role and the importance of eggs in the equilibrium of human nutritional balance necessary for assuring an optimal heath state at all age categories.

The above mentioned benefits are valid only for fresh eggs, because with their aging a series of biochemical processes took place and lead to a progressive degradation of initial qualities till alteration stage is reached (Stănescu, 1998).

For eggs delivered in shell, even if were tested several preservation methods, the one which gave the best results was refrigeration, method applied nowadays in the majority of world avian units (Jacob *et al.*, 2000).

Even if proved its efficiency in time, eggs storage in refrigeration regime could generate quite serious problems, especially when are not respected the storage conditions (especially at thermal level), delivery (refrigerated eggs must be warm up gradually) or by the quality of eggs subjected to refrigeration (dirty eggs, with broken shell, old etc) (Jones and Musgrove, 2005).

To increase the shelf life time of eggs and for a superior capitalization of them (in correlation with markets' demands and the requirements of processing units which use eggs as raw/auxiliary materials), were introduced in industrial processing the so called "derivates from eggs", food which kept in great part the qualities of natural product, but had a better preservation than it (Vacaru-Opriș *et al.*, 2004).

The main derivates from eggs which are nowadays processed are dehydrated products (egg powder) and the liquid ones (refrigerated or frozen). Technological properties of those products (emulsify, coagulate, binder power), make them very appreciated, especially that at those qualities is added the quite low price, in comparison with other animal origin proteins (Bondoc and Șindrilar, 2002).

So by the current paper we aimed to analyze a series of physical-chemical parameters of integral egg powder, to be able to establish its quality parameters and the time in which product is degraded.

MATERIALS AND METHODS

To achieve the aim were realized 3 batches (Lc egg powder packed in polyethylene bags stored at +4˚C and M.C. = 80%; Lexp-1 egg powder packed in polyethylene bags stored at +22÷32˚C, M.C. = 50÷70% and batch Lexp-2 egg powder packed in paper bags stored at +22÷32˚C, M.C. = 50÷70%) storage time being 180 days, determinations (sensorial characteristics, solubility, pH value, water content, dry matter content and content in mineral substances) were realized at each 30 days.

Sensorial characteristics of egg powder were determined based on a scoring system, characterized by the fact that for each property are establish 5 quality levels, "0" mark being attributed to a product with major modifications or even altered.

Solubility (%) was determined by appreciation of the sediments obtained after centrifugation of a certain quantity of egg powder (100 - % insoluble).

pH value was determined using an electronic pH-meter, by electrode immersion into an aqueous extract (10 g product and 100 ml distilled water, repos 20 minutes at room temperature, followed by filtration).

Water content (%) was establish by oven drying method, content in dry matter was determined using the following formula (S_{ur} = 100 - U_r where U_r = relative content in water).

Content in mineral substances (mg/100g) was determined by atomic absorption spectrophotometric method (AAS), with a GBC-AVANTA spectrophotometer. For determination were used already made solutions (1 mg/ME/ml), certificated (Merck brand). From etalon solutions were gathered stock solutions (from 10 ml of etalon solution will be obtained 100 ml with deionized water) with a concentration of 10 mg/l, and form those (through a new dilution) were prepared final solutions with a concentration of 1 mg/l.

Egg powder samples were burnt and after that calcined. Ash from crucible was moisture with water, then placed on a water bath for evaporation of water, finally being introduced in oven (till a complete calcinations of sample). Ash from crucible is moisture with water and it is replaced in oven; this operation is repeated till a complete calcinations. In crucible is added 10 ml HCl (6 M), covered with a watch glass and warmed up on a water bath for 15 minutes, after that is added 1 ml HNO_3; warming up continues for about one hour and after that is added 1 ml HCl (6 M), stir and added 10 ml of distilled water.

The obtained samples are placed on a water batch till a complete dissolution, taking care not to be complete dried. After this procedure the content of ampoule is chilled, filtered and transferred into a 50 ml flacon, by bringing at quota by completing with distilled water. The obtained solutions are introduced in device for reading of calibration curve.

To obtain the calibration curve absorbance is measured starting with the weakest one. With the obtained results calibration curve is drawn, representing graphical absorbance function of concentration; calibration curves for Ca, Fe and Mg were realized in 3 points and the ones for Zn in 4 points.

The obtained data were statistically processed, calculating arithmetic mean, standard deviation, standard deviation of mean and variation coefficient; statistical differences between batches were established using FISHER test. When were identified differences at least as significant, their source was determined by STUDENT test.

RESULTS AND DISCUSSION

Sensorial appreciations were identified on fresh product (day 0) then at 30 and 60 days did not enlightened modifications of parameters, each batch receiving maximum of points, respectively 20 (Tab. 1).

Starting with day 90 of storage, sensorial characteristics of egg powder, sensorial characteristics of egg powder for all three batches had a different evolution, function of packing type and assured storing conditions. For egg powder samples from batch Lc (packed in polyethylene bags; stored at +4°C and 80% MC) and Lexp-1 (packed in polyethylene bags; stored at +22…+32°C and 50…70% MC), sensorial characteristics maintain constantly good till day 180 of storage. At batch Lexp-2, the first instable agglomeration of egg powder appeared after 90 days of storage, being more obvious at the further effectuated controls. Solubility of egg powder decreased from one control stage to another under the influence of assured storing conditions.

So for fresh product solubility value was 90.4±0.51% at batch Lc, 90.4±0.68% at batch Lexp-1 and 90.8±0.58% at batch Lexp-2. The studied character presented a very good homogeneity for batches, a proof being the values of variation coefficient of only 1.26–1.68%. From statistical point of view in this period weren't observed differences with a statistic signification (Tab. 2).

After 30 days of storage solubility of egg powder was 90.4±0.68% at batch Lc (storage at +4°C, M.C. = 80% and packed in polyethylene bags), 89.2±0.80% at batch Lexp-1 (storage at +22…+32°C, M.C. = 50…70%; packed in polyethylene bags), 86.0±0.95% at Lexp-2 (stored in the same conditions as batch Lexp-1, difference being made by the packing way, in those case in paper bags). Even if character presented a very good homogeneity at batches' level (V% = 1.68–2.47), between them were significant differences.

Also at the other effectuated controls was observed a progressive decrease of product solubility, so at the end of investigations (day

Tab. 1. Sensorial characteristics of egg powder

Period	Experimental batch	Sensorial characteristics and obtained score				
		Aspect	Consistency	Smell and taste	Colour	Total points number
0 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	5	5	5	5	20
30 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	5	5	5	5	20
60 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	5	5	5	5	20
90 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	4	4	5	5	18
120 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	4	4	5	5	18
150 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	4	4	5	5	18
180 (n = 5)	Lc	5	5	5	5	20
	Lexp-1	5	5	5	5	20
	Lexp-2	3	3	5	5	16

Tab. 2. Solubility of powder egg

Durata de depozitare (zile)	Specificare	$\bar{X} \pm s_{\bar{X}}$	V%	Minima (%)	Maxima (%)
0	1	2	3	4	5
0 (n = 5)	Lc	90.4±0.51	1.26	89	92
	Lexp-1	90.4±0.68	1.68	88	92
	Lexp-2	90.8±0.58	1.44	89	92
	Testul FISHER	$\hat{F}_{0.15} < F5\%(3.88) \rightarrow n.s.$			
30 (n = 5)	Lc	90.4±0.68	1.68	88	92
	Lexp-1	89.2±0.80	2.01	87	91
	Lexp-2	86.0±0.95	2.47	84	89
	Testul FISHER	$\hat{F}_{7.76} > F1\%(6.93) < F0.1\%(12.97) \rightarrow **$			
	Testul STUDENT		Lexp-2	Lexp-1	Lc
		Lc	4.4**	1.2 n.s	0
		Lexp-1	3.2**	0	
		Lexp-2	0		
			$t_{5\%} = 3.7$; $t_{1\%} = 4.11$		
60 (n = 5)	Lc	90.2±0.73	1.82	88	92
	Lexp-1	89.0±0.55	1.38	87	90
	Lexp-2	83.6±1.44	3.84	80	88
	Testul FISHER	$\hat{F}_{12.78} > F1\%(6.93) < F0.1\%(12.97) \rightarrow **$			
	Testul STUDENT		Lexp-2	Lexp-1	Lc
		Lc	6.6***	1.2 n.s.	0
		Lexp-1	6.6***	0	
		Lexp-2	0		
			$t_{5\%} = 3.70$; $t_{1\%} = 4.95$		
90 (n = 5)	Lc	90.0±0.71	1.76	88	92
	Lexp-1	87.2±1.16	2.97	84	91
	Lexp-2	80.0±0.71	1.98	78	82
	Testul FISHER	$\hat{F}_{34.12} > F0.1\%(12.97) \rightarrow **$			
	Testul STUDENT		Lexp-2	Lexp-1	Lc
		Lc	10.0***	2.8 n.s	0
		Lexp-1	7.2***	0	
		Lexp-2	0		
			$t_{5\%} = 3.32$; $t_{1\%} = 4.45$		
120 (n = 5)	Lc	89.8±0.80	1.99	88	92
	Lexp-1	82.6±0.93	2.51	80	85
	Lexp-2	68.6±0.93	3.02	66	71
	Testul FISHER	$\hat{F}_{147.73} > F0.1\%(12.97) \rightarrow ***$			
	Testul STUDENT		Lexp-2	Lexp-1	Lc
		Lc	21.2***	7.2***	0
		Lexp-1	14.0***	0	
		Lexp-2	0		
			$t_{5\%} = 3.34$; $t_{1\%} = 4.47$		
150 (n = 5)	Lc	89.6±0.81	2.03	88	92
	Lexp-1	82.4±0.51	1.38	81	84
	Lexp-2	67.6±0.51	1.69	66	69
	Testul FISHER	$\hat{F}_{319.86} > F0.1\%(12.97) \rightarrow ***$			
	Testul STUDENT		Lexp-2	Lexp-1	Lc
		Lc	22.0***	72***	0
		Lexp-1	14.8***	0	
		Lexp-2	0		
			$t_{5\%} = 2.36$; $t_{1\%} = 3.16$		
0	1	2	3	4	5
180 (n = 5)	Lc	89.4±0.51	1.28	88	91
	Lexp-1	78.4±1.29	3.67	74	82
	Lexp-2	66.4±0.51	1.72	65	68
	FISHER test	$\hat{F}_{182.11} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lexp-2	Lexp-1	Lc
		Lc	23.0***	11.0***	0
		Lexp-1	11.0***	0	
		Lexp-2	0		
			$t_{5\%} = 3.21$; $t_{1\%} = 4.30$		

Note: ns = insignificant differences, ** = significant differences, *** = very significant differences.

180 of storage), the recorded values for this quality parameter were 89.4±0.51% at batch Lc, 78.4±1.29% at batch Lexp-1 and only 66.4±0.51% at batch Lexp-2. Statistical differences between those three batches were significant. Also at this last control stage were founded very low values for variation coefficient (V% = 1.28–3.67), which highlight the homogeneity of studied character for each batch.

Analysis on dynamics of pH value for integral egg powder show its increase from one stage to another, under the influence of assured microclimate factors and pack type.

So for fresh egg powder (before storage) pH value was 8.12±0.04 at batch Lc (minimum 8.00 and maximum 8.20), 8.08±0.04 at batch Lexp-1 (with variation limits between 8.00 and 8.20) and for batch Lexp-2 was 8.09±0.05 (minimum 8.00 and maximum 8.24). The studied character presented a very good homogeneity at batches, a proof being the values of variation coefficient of only 1.03–1.40%. At this first effectuated control weren't observed differences with statistical significance between compared batches.

At the control made at the end of experiment (day 180) pH mean value for batch Lc was 8.27±0.02, minimum being 8.21 and maximum being 8.31. Regarding the variation coefficient, calculated value was 0.46% which shown a very good homogeneity inside batch. For batch Lexp-1, pH value was 8.80±0.01, with variation limits between 8.78 and 8.82; also for this batch studied character presented a very good homogeneity, value of variation coefficient being 0.19%. For batch Lexp-2, mean pH value was 8.93±0.03, with variation limits between 8.88–9.02; variation coefficient was 0.64%, resulting a very good homogeneity.

Must be mentioned the fact that starting with day 30 of storage till the end of experiment between batches existed very significant statistical differences (Tab. 3).

Determinations realised on integral fresh egg powder (day 0), show a water content of 4.93±0.07 at batch Lc and 4.94±0.07 at batches Lexp-1 and Lexp-2; studied character presented a good homogeneity for all the three analysed batches (V% = 0.65–0.82). Differences between batches increased with storage period, so at the end of experiment (day 180 of storage), water content in analysed product recorded a mean level of 5.00±0.04% at batch Lc, 5.21±0.03% at batch Lexp-1 and 6.52±0.51% at batch Lexp-2. Also at this control stage character homogeneity maintained at very good levels (V% = 0.28–0.42) (Fig. 1).

Statistical analysis between experimental batches show the fact that distinct significant differences observed in day 90 of storage transformed further in very significant, maintaining in this way till the last day of storage.

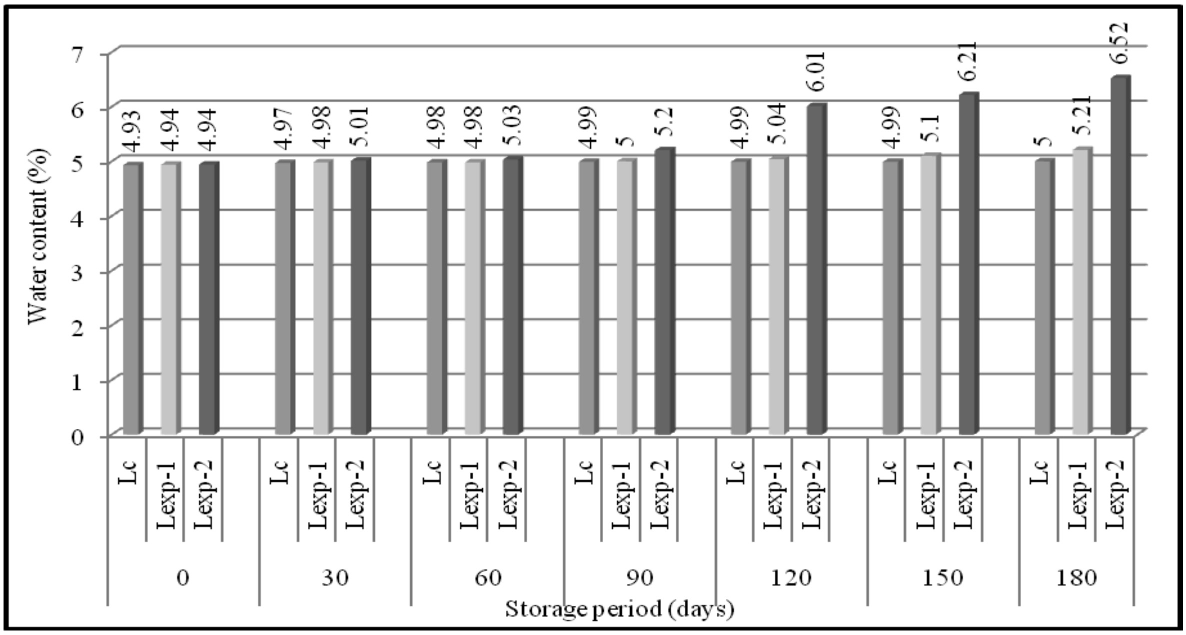

Fig. 1. Evolution of water content in egg powder

Tab.3. pH evolution of powder egg

Storage period (days)	Specification	$\bar{X} \pm s_{\bar{x}}$	V%	Minimum (%)	Maximum (%)
0	*1*	*2*	*3*	*4*	*5*
0 (n = 5)	Lc	8.12±0.04	1.03	8.00	8.20
	Lexp-1	8.08±0.04	1.04	8.00	8.20
	Lexp-2	8.09±0.05	1.40	8.00	8.24
	FISHER test	$\hat{F}_{0.52} < F5\%(3.88) \rightarrow n.s.$			
30 (n = 5)	Lc	8.09±0.01	0.20	8.07	8.11
	Lexp-1	8.19±0.01	0.25	8.17	8.22
	Lexp-2	8.22±0.01	0.23	8.19	8.24
	FISHER test	$\hat{F}_{66.13} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.13***	0.03***	0
		Lexp-1	0.10***	0	
		Lc	0		
			$t_{5\%}$ = 0.06; $t_{1\%}$ = 0.09		
60 (n = 5)	Lc	8.12±0.01	0.21	8.11	8.15
	Lexp-1	8.36±0.03	0.68	8.28	8.41
	Lexp-2	8.49±0.01	0.17	8.47	8.51
	FISHER test	$\hat{F}_{139.03} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.37***	0.13***	0
		Lexp-1	0.24***	0	
		Lc	0		
			$t_{5\%}$ = 0.06; $t_{1\%}$ = 0.09		
90 (n = 5)	Lc	8.17±0.02	0.55	8.11	8.22
	Lexp-1	8.48±0.01	0.24	8.45	8.50
	Lexp-2	8.57±0.02	0.36	8.25	8.61
	FISHER test	$\hat{F}_{181.53} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.40***	0.09***	0
		Lexp-1	0.31***	0	
		Lc	0		
			$t_{5\%}$ = 0.06; $t_{1\%}$ = 0.08		
120 (n = 5)	Lc	8.18±0.01	0.35	8.15	8.21
	Lexp-1	8.60±0.01	0.19	8.58	8.62
	Lexp-2	8.69±0.01	0.19	8.66	8.70
	FISHER test	$\hat{F}_{212.04} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.50***	0.09***	0
		Lexp-1	0.42***	0	
		Lc	0		
			$t_{5\%}$ = 0.04; $t_{1\%}$ = 0.05		
150 (n = 5)	Lc	8.20±0.01	0.20	8.18	8.22
	Lexp-1	8.66±0.02	0.50	8.59	8.70
	Lexp-2	8.76±0.02	0.49	8.69	8.80
	FISHER test	$\hat{F}_{336.98} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.56***	0.10***	0
		Lexp-1	0.46***	0	
		Lc	0		
			$t_{5\%}$ = 0.06; $t_{1\%}$ = 0.08		
0	*1*	*2*	*3*	*4*	*5*
180 (n = 5)	Lc	8.27±0.02	0.46	8.21	8.31
	Lexp-1	8.80±0.01	0.19	8.78	8.82
	Lexp-2	8.93±0.03	0.64	8.88	9.02
	FISHER test	$\hat{F}_{366.42} > F0.1\%(12.97) \rightarrow ***$			
	STUDENT test		Lc	Lexp-1	Lexp-2
		Lexp-2	0.66***	0.13***	0
		Lexp-1	0.53***	0	
		Lc	0		
			$t_{5\%}$ = 0.07; $t_{1\%}$ = 0.09		

Note: ns = insignificant differences, *** = very significant differences.

Naturally content in dry matter of integral egg powder studied by us recorded a descendant evolution, at the same with increasing of products' water content.

At batch Lc, dry matter was 95.07±0.09% for the fresh one (day 0) and 95.00±0.04% after 180 days of storage. Studied character presented a good homogeneity inside this batch, with variation coefficient values of 0.02–0.04% (Fig. 2).

At batch Lexp-1, determination of dry matter show values of 95.06±0.07% for fresh product and 94.79±0.02% for the one stored for 180 days, mentioning a very good homogeneity at batch level (V% = 0.01–0.06).

For batch Lexp-2, packing way and even storage conditions permitted absorption of atmospherically water, so from an initial level of 95.06±0.07% DM, at the end of experiment (day 180 of storage) was obtained a value of only 93.48±0.03%. Despite that studied character presented a very good homogeneity at batch level for each control stage (V% = 0.01–0.06).

From statistical point of view between batches were founded distinct significant differences at control effectuated in day 90 of storage, after which differences became very significant, keeping this trend till the end of experience.

Regarding iron content, at first realized control, was identified a mean value of 1.48±0.08 mg/100 g at batch Lc, 1.49±0.08 mg/100 g at batch Lexp-1 and 1.47±0.11 mg/100 g at batch Lexp-2. Values of variation coefficient calculated for this parameter were between 2.49% and 3.76%, which represent a good homogeneity for the studied character. During storage period were recorded small fluctuations of iron in the analyzed egg powder, without reaching statistically differences between batches (Fig. 3).

For zinc content, in fresh egg powder was recorded a mean value of 1.14±0.09 mg/100 g at batch Lc, 1.17±0.10 mg/100 g at batch Lexp-1 and 1.11±0.07 mg/100 g at batch Lexp-2. Regarding the variability of studied character for all three batches, this one presented a very good homogeneity, values of variation coefficient being of 2.87–3.62%. As in case of iron content, mean calculated values for each batch were constant during the whole period of research, without any significant statistical differences (Fig. 4).

Regarding calcium content, at realised control on fresh product (day 0), was identified a level of 49.10±0.97 mg/100 g at batch Lc, 49.66±0.67 mg/100 g at batch Lexp-1 and 48.76±1.55 mg/100 g at batch Lexp-2. Value of variation coefficient was 0.60–1.42%, fact which confirms the existence of a very homogenous character inside batches. Values were quite constant during whole research period, not being influenced by the microclimate factors and packing mode of analysed product (Fig. 5).

For magnesium content, mean values founded for fresh product (day 0) were 10.09±0.22 mg/100 g at batch Lc, 10.30±0.53 mg/100 g at batch Lexp-1 and 10.24±0.63 mg/100 g at batch Lexp-2. Values of variation coefficient were under the level of 10% (V% = 0.97–2.77), fact which show a good homogeneity inside batches (Fig. 6).

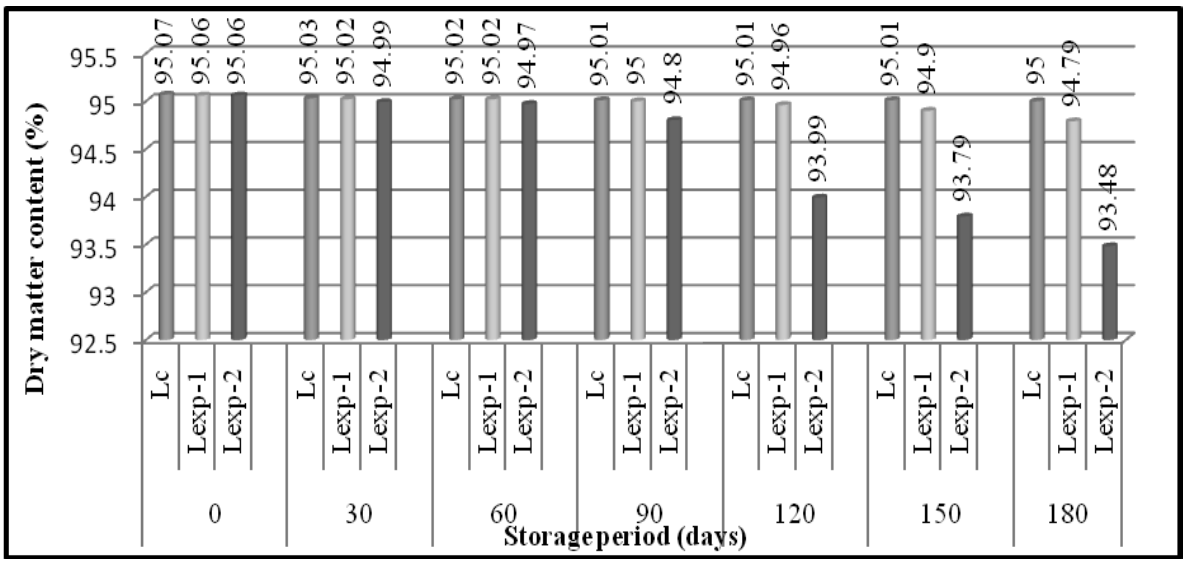

Fig. 2. Evolution of dry matter content in egg powder

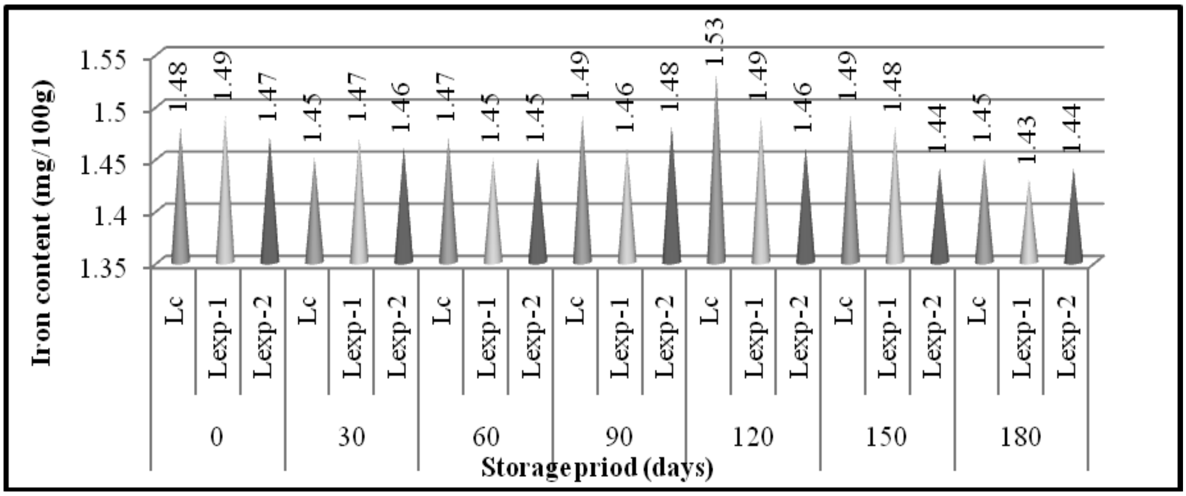

Fig. 3. Iron content evolution in powder egg

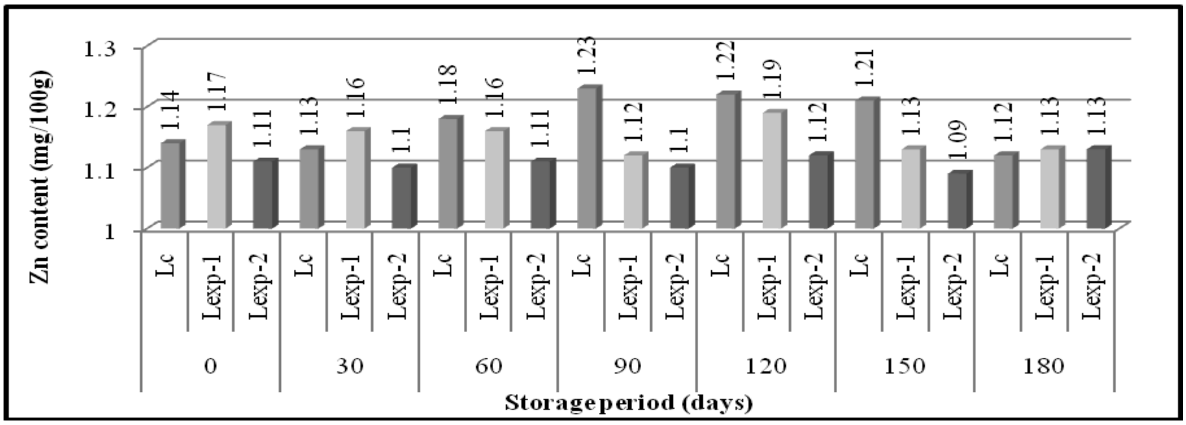

Fig. 4. Evolution of Zn content in egg powder

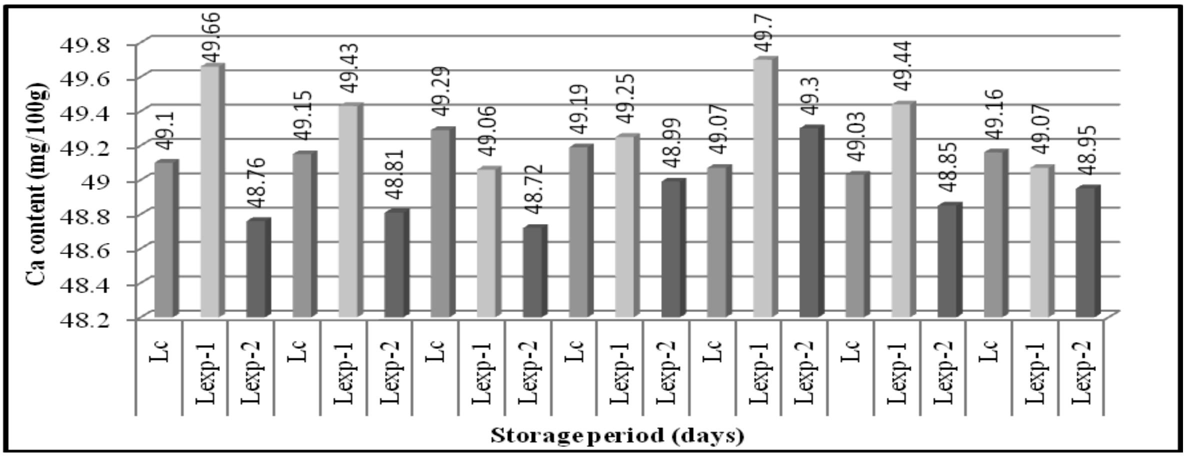

Fig. 5. Evolution of Ca content in egg powder

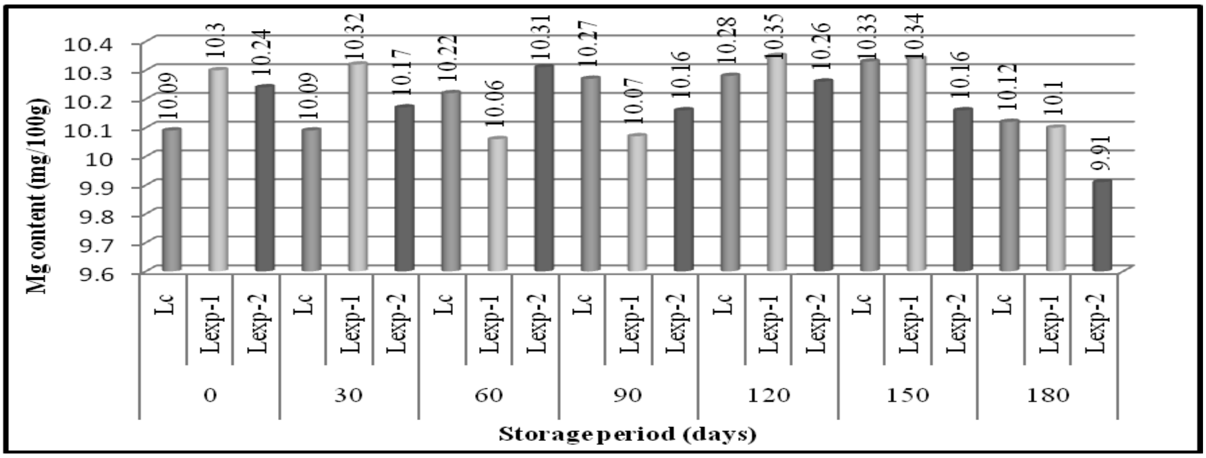

Fig. 6. Evolution of Mg content in egg powder

CONCLUSION

Based on the research on integral egg powder can conclude that this one had several modifications of sensorial and quality physical indicators, function, of assured experimental factors (packing way and storage conditions).

At the first control realised to determine the sensorial indicators (day 0), all three batches received a maximum score, situation which maintain till day 90 of storage, when product from batch Lexp-2 (egg powder packed in paper bags and stored at +22…+32°C and 50...70% moisture content) when presented the first modifications regarding aspect and consistency (instable agglomerations), which had a further development.

Regarding solubility of integral egg powder, the obtained values at the end of those 180 days of storage highlighted more or less accentuated modifications under the action of experimental factors, these one being smaller with 1.10% at batch Lc, 13.27% at batch Lexp-1 and with 26.87% at batch Lexp-2, in comparison with the specific levels of fresh product.

Comparing with the pH values recorded at fresh product (day 0), the ones determined at the end of those 180 storage days were higher with 1.84% at egg powder samples from batch Lc (packed in polyethylene bags and stored in refrigeration conditions), with 8.91% at batch Lexp-1 (packed in polyethylene bags and stored in ambient environment) and with 10.38% at batch Lexp-2 (packed in paper bags and stored at room temperature).

Experimental factors (pack type and storage conditions) affected only water content of product and implicit the one in dry matter, without introducing modifications at the components level (mineral substances).

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