SUMMARY

Keywords: egg products, storage, refrigeration, pasteurization, quality

Egg products have emerged as a need to counterbalance the excess of eggs on the market, but also as response to the demands of the modern consumer, with a higher shelf life and superior and unaltered quality of eggs used as raw material.

This is why in the doctoral thesis entitled "***Contributions to the knowledge of the quality of pasteurized liquid egg products obtained in our country***" we intend to study both the quality indicators and their stability during storage, for three different assortments, namely pasteurized liquid melange; pasteurized liquid yolk; pasteurized liquid albumen.

Two major objectives were considered for each egg product analyzed:

Objective 1 targeted to establish the qualitative parameters of the studied egg products (melange / yolk / albumen liquid pasteurized).

In order to achieve this goal, were carried out on samples taken on the day of manufacture; sensorial, physical-chemical and microbiological assessments of each to three egg products.

The purpose this objective of the PhD thesis was to confirm/infirm the manufacturer's technical specifications and possibly to complete the information package accompanying each of the three egg products, with data attesting to its food value in order to determine whether the processing destroys/decreases or not the native nutritional properties of raw material respectively eggs.

Objective number 2 was focused on studying storage stability (storage) of egg products.

For this purpose, the same type of qualitative assessments (sensorial, physical-chemical and microbiological) on the same egg products (melange / yolk / pasteurized liquid albumen) were performed during refrigeration storage (temperature = 0 ... + 4 °C, relative humidity = 65%) over a period of time equal to that recommended by the manufacturer: maximum 25 days for pasteurized melange and maximum 28 days for pasteurized yolk and egg albumen.

Through this goal the PhD thesis, it was intended to check whether a pasteurized liquid egg products may be consumed for a shorter or longer time after the opening of the pack and especially if the maximum shelf life (48 hours) recommended by the producer is influenced by the age of the product, even under the refrigeration conditions storage.

In order to assess the storage stability of the pasteurized melange, four batches were constituted for each product analyzed as follows: M-1, M-2, M-3 and

M-4 batches for melange, batches G-1, G- 3 and G-4 for yolk and A-1, A-2, A-3 and A-4 for albumen respectively; each batch consisted of 5 units of bag-in-box packaging.

For the sampling with specific analyzes, it was necessary to unsealing the packages, which was differentiated on batches: for M-1, G-1 and A-1 batches the packaging was unloaded from the first day of storage, at M-2, G -2 and A-2 were dissected on the 7^{th} day of storage, at batches M-3, G-3 and A-3 on day 14, and at batches M-4, G-4 and A-4 on the 21^{st} day of storage.

Sampling and qualitative analyzes were performed from the day of storage in which the packages were unsealed until the day of storage when the sensory examination indicated that the product was unfit for consumption (it received less than 12 points in the sensory evaluation).

In the current paper, the **initial quality of the egg pasteurized liquid products** was monitored from the perspective of several indicators than those specified in the data sheet.

From a sensory point of view, it was observed that the pasteurized melange obtained a total score of 19.6 points out of a maximum of 20 points; Deposits were recorded in appearance and consistency.

Regarding the physical properties, a pH value of 7.54 ± 0.02 was recorded, and with respect to hydrogen sulphide its presence was observed in none of the analyzed samples was evidenced, which indicates the freshness of the product.

The slightly hydrolysable nitrogen content was on average 10.93 ± 0.18 mg NH_3/100g below the maximum permitted by law.

The results on viscosity reveal its decrease as the speed of rotation increases; thus the value recorded at 5 rpm was 427.51 ± 2.82 mPa.s and at the speed of 80 rpm was 243.02 ± 2.60 mPa.s.

From a chemical point of view, an average water value of 75.59 ± 0.04% was obtained, while the dry matter content was 24.41 ± 0.04%.

Determination of the protein content indicated an average value of 12.22±0.04%, the lipid content was 9.71±0.03%, the total mineral substances were 0.99 ± 0.01% and the value average of nitrogen free extracts was 1.48±0.04%.

Data obtained on the amino acid content of the liquid pasteurized melange indicates a total value of 47.18 g/100g, of which 22.54 g/100g were essential amino acids and 24.64 g/100g non-essential amino acids.

Determination of the fatty acid content revealed a total saturated value of 34.57±0.13 g/100g fat, 42.33±0.07 g/100g fat for the monounsaturated and 22.86±0.16 g/100g fat for polyunsaturated acids.

Concerning the calcium content, an average value of 46.90 ± 0.17 mg/100 g was obtained, the phosphorus content was 181.50±1.90 mg/100g and the magnesium content had a value of 8.76 ± 0.26 mg/100g.

With regard to microbiological parameters, it was found that TNAMG value was 2.65 ± 0.01 log cfu/ml, and the *Enterobacter spp.* bacteria recorded an average of 0.54 ± 0.01 log cfu/ml; we state that the values obtained were below the maximum set by the legislation in force.

Regarding the presence of bacteria *Staphylococcus aureus* and *Salmonella spp.*, these were not evidenced in the melange samples.

As a result of the sensory analysis, the total score obtained by the pasteurized yolk was 19.8 points, which was only scored for consistency.

The results obtained indicate a level of 5.93±0.01 for the pH value, the absence of hydrogen sulphide in the analyzed samples and a slightly hydrolysable nitrogen content of 6.57 ± 0.06 mg NH_3/100g below the maximum permitted by law in effect, evidence of the freshness of the yolk analyzed by us.

From the data on the viscosity of the yolk we note that it has the same pseudo-plastic character, but the recorded values were much higher; thus, the viscosity recorded at 5 rpm was 1880.50 ± 42.53 mPa.s, while at the speed of 80 rpm the average obtained was 1204.60 ± 23.68 mPa.s.

The chemical composition of the yolk showed a water content of 57.38±0.13%, while for dry substance the average obtained was 42.62 ± 0.13%.

The average protein content was 14.60±0.04%, for lipids it was 25.38±0.08%, the total minerals content was 1.56±0.01%, while the mean value of nitrogen free extracts was 1.08±0.06%.

Data obtained for amino acids indicates a total value of 47.18 g/100g, of which 47.62% were essential amino acids and 52.38% non-essential amino acids.

From the fatty acid analysis it was observed that the sum of the saturated ones was 34.42 ± 0.08 g/100g of fat, the monounsaturated fatty acids 41.40 ± 0.09 g/100g, while the recorded average of the polyunsaturated acids of was 19.18 ± 0.06 g/100g fat.

The results obtained with the studied minerals indicate that the calcium content was 110.40 ± 1.57 mg/100g, the phosphorus was at a level of 537.20 ± 1.58 mg/100g, while the content of magnesium from yolk was 13.10 ± 0.38 mg/100g.

The total number of anaerobic mesophilic germs had an average of 1.65±0.06 log cfu/ml, and the *Enterobacter spp*. bacteria recorded only 0.80±0.03 log cfu/ml, being below the maximum limit set by the legislation in force.

We mention that pathogens such as *Staphylococcus aureus* and *Salmonella spp*. were not present in the product we analyzed.

Egg albumen, despite being overwhelmed in appearance and consistency, scored a total score of 19.4 points, getting the qualifier very well.

The physical quality of the product was highlighted by the pH value of 8.29±0.01 and the absence of colour changes as a result of the hydrogen sulphide

analysis indicated the freshness of the analyzed product; with respect to the slightly hydrolysable nitrogen content, the recorded average was 9.27 ± 0.16 mg NH_3/100g.

The viscosity of the analyzed egg albumen has the same pseudo-plastic character as the other egg products analyzed; the average obtained at the speed of 5 rpm was 41.06 ± 2.01 mPa.s, while at the speed of 80 rpm it was only 15.33 ± 0.42 mPa.s.

The data obtained on the chemical composition indicates an average water content of 88.48 ± 0.05% and the dry matter content of 11.52 ± 0.06%.

The protein content was 10.23 ± 0.05%, the lipid content was 0.02 ± 0.00%, total mineral substances had an average of 0.72 ± 0.01% and the nitrogen free extracts have recorded 0.55 ± 0.01%.

The sum of the essential amino acids was 35.94 g/100g and the nonessential 42.07g/100g, totalling 78.01g/100g.

As for minerals, a mean calcium content of 6.18±0.01 mg/100g was observed, the phosphorus content being 11.46±0.01 mg/100g and the magnesium content of 7.27 ± 0.02 mg/100g.

The microbiological quality of the egg albumen was highlighted by the analysis of the total number of anaerobic mesophilic germs, which recorded an average of 1.14 ± 0.02 log cfu/ml but also by identifying bacteria of *Enterobacter spp*., which recorded 0.34 ± 0.01 log cfu/ml, being lower than the maximum limits provided by current legislation.

Pathogens such as *Staphylococcus aureus* and *Salmonella spp*. were not identified in the analyzed samples.

The **stability of the egg products during the shelf-life** was presented for each product at specified intervals.

After the sensory analysis of the pasteurized melange, the product deterioration was recorded with the storage period, from a score of 19.6 points recorded on the first day to 11.2 points obtained on the last day of the analysis (day 24).

As for the hydrogen sulphide in the analyzed product, it showed a correlation between the physical and the sensory indicators, its presence being signalled from day 4 in the case of the M-1 batch, respectively, in the case of M-2, M-3 and M-4.

With regard to viscosity, a numerical decrease was observed at each rotational speed due to con-albumin degradation.

From a chemical point of view, slight decreases in water content and increase in dry matter content have been observed.

The melange proteins followed an ascending line during the storage period with values ranging from 12.22 ± 0.04% on the first day, and then on day 24 they recorded values of 12.97 ± 0.03%. The determined lipid content ranged between 9.71-9.86%.

The results for total mineral substances indicate a constant content of 0.99% for each batch under study. The calcium content of the pasteurized liquid melange ranged from 46.90-48.66 mg/100g, the phosphorus content between 181.50-195.90 mg/100g and the magnesium level in the product showed an increase from 8.98 mg/100g on the first day of assay at 10.45 mg/100g on day 24.

Regarding the total number of anaerobic mesophilic germs, it recorded an increase in each analyzed batch, exceeding the maximum admissible limit on day 6 for the M-1 batch, 11 for the M-2 batch, in the 18th day of storage for batch M-3 and on day 23 for the last batch.

As for *Enterobacter spp*., we find a secondary contamination of melange that does not endanger the health of consumers. Bacteria from genus *Staphyloccocus aureus* and *Salmonella spp*. were not present at any stage of analysis during storage.

Sensitive, the pasteurized yolk presented an initial score of 19.8 points, subsequently being declared unfit for consumption, obtaining a score lower than the 12 points in the 8th day for batch G-1, the 13 for G-2, 17 for batch G-3 and 25 for batch G-4.

Determination of hydrogen sulphide reveals its presence from the 4th storage day for batch G-1, from the 9th day for G-2 batch, from the 16th day for the product in the G-3 batch, and in the case of the last batch on the 23rd day of storage.

The evolution of slightly hydrolysable nitrogen confirms the faster degradation of the product after opening of the packaging.

Regarding viscosity, irrespective of the rotation speed, it showed a decline over the entire storage period from 1880.50±42.53mPa.s (first day) to 1213.73±22.85 mPa.s (day 8) at 5 rpm.

The protein content of the studied yolk increased in each batch; while the yolk lipids were uniformly comprised between 25.38% (first day) and 25.54% (day 25).Total determined mineral substances ranged from 1.55-1.61%.

Calcium contain in yolk had values between 110.40-112.90 mg/100 g, and magnesium recorded averages of 13.10 ± 0.37 mg/100g (first day) and 14.38± 0.36 mg/100g (day 25).

The weight of nitrogen free extract was 1.08 ± 0.06% on the first day of storage, reaching 1.33 ± 0.09% on day 25.

Enterobacter spp. recorded values between 0.80-2.70 log cfu/ml; the other microbiological indicators analyzed (*Staphyloccocus aureus* and *Salmonella spp.*) were not identified at any of the analytical steps performed.

From a sensory point of view, the pasteurized albumen is depreciated from 19.6 points as it was at the first determination to less than 12 points that classify the product as being inappropriate for consumption.

The pH value has been steadily increasing over the storage period for all four batchs.

As regards hydrogen sulphide, the presence in the albumen of batch A-1 was highlighted from the 5th day of storage, in batch A-2 starting on day 11 and in the case of the other two batches it was present beginning with day 17th and 23rd respectively.

With regard to viscosity, we notice that it has tended to decrease over the entire storage period regardless of the speed of rotation.

The albumen protein content indicated an increase from 10.22 ± 0.04% on the first day of storage to 10.32 ± 0.04% on day 25. The recorded lipids were at a constant level of 0.02% throughout the storage.

Results for total mineral substances showed slight oscillations, ranging from 0.71-0.73%.

The calcium content of the pasteurized liquid albumen had values between 6.15-6.19 mg/100g, phosphorus had values of 11.40-11.48 mg/100 g, and the magnesium was between 7.26-7.34 mg/100g.

As for the microbiological indicators we can see the proliferation of the psychotropic bacteria expressed by TNAMG ascent directly proportional to the storage period; also the presence of bacteria of the genus *Enterobacter spp.*, not exceeding the limit of 2 log cfu/ml imposed by the legislation in force, is observed.

High pathogenic bacteria for humans (*Staphyloccocus aureus* and *Salmonella spp*.) were not present in any of the batches under analysis.

Based on the results of our experience, we propose the following **recommendations**:

✓ Consumption of pasteurized liquid egg products produced in Romania, as they have normal physical-chemical and microbiological characteristics, according to the manufacturer's specifications and national legislation;

✓ The use in human consumption of pasteurized liquid egg products because it largely preserves the nutritional and dietary properties of the eggs from which they come;

✓ Keeping pasteurized liquid egg products only in the original packaging and at temperatures in the refrigeration area (0 ... + 4°C);

✓ The use in the gastronomy/food industry of only pasteurized liquid sheep products in the shelf-life and within 48 hours of unloading the packaging;

✓ The usage of bag-in-box packaging for liquid and even other food products because the closing system limits the product’s contact with the external environment, extending its shelf-life.