# CONTRIBUTIONS TO KNOWLEDGE OF CHEMICAL COMPOSITION OF EGGS LAID BY HENS REARED IN LOFT

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**Abstract**

*Establishment of chemical composition for albumen, yolk and mineral shell was realised on eggs gathered at four different ages (20, 31, 40 and 60 weeks) from birds belonging to ISA Brown hen hybrid, reared in two systems: battery and respectively loft; both birds' batches having the same maintenance and feeding conditions. The obtained results shown the fact that regarding chemical composition of yolk and albumen weren't significant differences between those two batches. However, in case of eggs laid by hens exploited in loft were founded higher levels for content in dry matter of yolk (9.08 g vs. 8.99 g for eggs from battery) and albumen (4.18 g vs. 4.16 g), but also for proteins from yolk (2.69 g vs. 2.65 g) and from albumen (3.48 g vs. 3.46 g). Mineral substances from shell of eggs laid by birds reared in loft were founded into a quantity of 6.94 g, and at the eggs gathered from battery was 6.73 g, hence the significant differences between batches. In conclusion, we can say that loft rearing system allow to obtain eggs with a better chemical content face to rearing in battery.*

**Key words:** loft, hens, eggs, chemical composition

## INTRODUCTION

Eggs' forming is controlled by endogenous and exogenous factors, with direct effects on components' rate and implicitly on their chemical composition [4, 11, 13].

During birds' lifetime, weight of eggs increase at the same time with aging, due to yolk rate increase, but without affecting its content in dry matter [2]; this phenomenon is accompanied by decreasing of dry matter in albumen [15].

Application of selection for productivity increasing at hens with the same eggs' weight, lead to obtaining of descendants whose eggs have a reduced rate of dry matter in melange (decrease the dry matter in yolk) [9, 17].

Birds' exposure at high temperatures and extreme moisture, determine a low decreasing of lipids in yolk, without affecting the dry matter content in albumen and yolk [1, 18].

Regarding the influence of maintenance system on eggs' chemical composition was observed that, in contrast with rearing in batteries, exploitation in field lead only to decreasing of yolk rate (with 2-4%) [7, 16], while eggs gathered from a free-range system have a little bit higher rates of lipids in yolk and for some certain vitamins ($B_{12}$ and folic acid) [3].

When laying hens receive mixed fodders with reduced protein levels, took place a diminishing of eggs' weight (decrease the yolk rate and into a much reduced way the one for albumen) [10].

Moderate deficiencies in lysine and methionine decrease the rate of albumen and proteins in its composition [5], while deficiencies in lysine and threonine lead to a decreasing of yolk weight [6].

Lack of linoleic acid from fodders reduce with almost 10 g the weight of eggs, due to diminishing of yolks' dry matter content [10, 15].

Quantity of minerals from eggs depend significantly by their assuring level in administrated mixed fodders [14].

Yolk of hen egg have the following content: 8.0-9.2 g water; 8.7-10.0 g dry matter; 2.7-3.2 g proteins; 6.0-6.8 g lipids, and also could be found carbohydrates, vitamins and mineral substances [12].

In albumen of a hen egg with a weight of 60 g, dry matter quantity is 3.8-4.5 g, the one

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of proteins is 3.3-4.0 g, carbohydrates are at a level of 0.12-0.16 g, and 0.16-0.24 g mineral substances [8].

Egg shell is composed by 95% mineral substances, 4.4% organic substances and 0.6% water [15].

## MATERIAL AND METHOD

Study was carried out on eggs gathered from ISA Brown hybrid, reared in two systems: Eurovent improved battery and Natura Nova Twin loft; for both rearing systems being assured the same maintenance and feeding conditions.

Determination of components' chemical composition (albumen, yolk and shell) was done on eggs gathered at four different age of birds (20, 31, 40 and 60 weeks), in according with specific methodology of scientific research:

- *dry matter content:* was calculated as difference between absolute value (100%) and product water content (%); water being determined by oven drying method, for 4 hours, at +105ºC;
- *lipids content:* was determine using Soxhlet method, based on fat extraction with an organic solvent.

Samples (2.5-3.0 g) placed in filter paper envelopes were putted in the extractor cartridges attached to extraction columns, than in each glass were added 80 ml of petroleum ether and chips for boiling.

Cartridges were immersed in pots when solvent started to boil and were kept for 30 min. at a temperature of +110ºC (immersion phase).

After that, cartridges with samples were washed for 120 min. in ether vapours, for drain of lipids and solvent in extraction pots (washing phase).

In the last stage, with a duration of 30 min., were recovered the rests of lipids and solvent. Extraction pots were taken out from device and were dried at oven till a constant weight (recovering phase).

Fat content was calculated as difference between pot mass after extraction and the one before extraction, rated at sample mass in according with formula:

$$G(\%) = \frac{m_f - m_i}{m} x100$$

where: $m_f$=final mass of extraction pot (g);
$m_i$=initial mass of extraction pot (g);
m=sample mass (g DM).

- *proteins content:* by Kjeldahl method, which is based on the fact that by heating with sulphuric acid and in the presence of a catalyser, nitrogen from organic combinations is transformed in ammonium sulphate.

Ammonia is released by adding a basis, and by distillation could be caught into a determined quantity of acid with a known normality; excess of acid is treated with a basis solution with the same normality and by difference is established the nitrogen quantity.

In each digestion tube of Kjeldahl-Velp device were introduced a working sample (1 g), 3 g of catalyser ($CuSO_4$+$K_2SO_4$) and 25 ml $H_2SO_4$ 96%.

In digestion phase (duration=210 min.) sample+catalyser+reagent mix was heated at three consecutive temperature stages (+120ºC; +240ºC; +420ºC), after that tubes were lifted for cooling and for adding of distillate water (20 ml/ampoule). Digestion tubes were attached at distillation port, and in capturing glass for nitrate solution were introduced 25 ml $H_3BO_3$ 4% and 5 drops of phenolphthalein. At the end, solution from glass was titre with $H_2SO_4$ 0.1N till the colour turned from pink to yellow.

$H_2SO_4$ volume utilised at titration and other quantities of utilised reagents were introduced in formula:

$$\text{Proteins}\,(\%) = \frac{0.0014\times 2\left(v_1 - \frac{v_2}{2}\times f\right)\times 6.25}{m}\times 100$$

where: $v_1$=volume of $H_3BO_3$ 4% introduced in glass (25 ml);
$v_2$=volume of $H_2SO_4$ 0,1N utilised for titration (ml);
f=factor of $H_2SO_4$ solution (1.1);
m=mass of sample (g).

- *dry matter content:* was determinate by calcinations method.

Analysed samples (3 g) were introduced in crucibles brought at constant mass, were carbonized at flame, after that were placed in calcinations oven, at +550ºC till residuum didn't presented black spots (correct calcinations).

After that, crucibles with samples were cooled and weighted, and then were reintroduced in calcinations oven for one hour; procedures of calcinations-cooling-weighting being repeated till a constant mass.

Ash content was calculated with the formula:

$$C(\%) = \frac{c \cdot 100}{m}$$

where: C=ash content (%);
c=burnt residuum (g);
m=mass of analysed sample (g).

Data were statistically processed, calculating: arithmetic mean ($\bar{X}$), standard deviation of mean (±sx) and variation coefficient (V%).

## RESULTS AND DISCUSSIONS

***Dry matter from yolk.*** From the obtained data resulted that at eggs provided by hens reared in battery yolk content in dry matter was lower than at hens from loft, but those differences hadn't a statistical significance.

So for example, at eggs from battery, dry matter from yolk varied between 8.55±0.12 g (start of laying) and 9.69±0.18 g (end of laying), and at the ones obtained in loft between 8.64±0.13 g (start of laying) and 9.80±0.19 g (end of laying).

Character was quite homogenous, limits of variation coefficient being of 6.21-10.49% at eggs from battery and 6.57-11.11% at the ones from loft (tab. 1).

***Proteins from yolk.*** Quantities oscillated between 2.53±0.02 g proteins (start of laying) and 2.84±0.03 g proteins (end of laying) at eggs laid by birds reared in battery respectively between 2.56±0.03 g proteins (start of laying) and 2.88±0.02 g proteins (end of laying) at hens reared in loft.

Weren't recorded higher values than 10% for variation coefficient (V%=4.33-5.91 at eggs from battery and V%=3.33-7.61 at the ones from loft) neither differences with statistical significance between those two batches (tab. 2).

Table 1 Dry matter quantity (g) from yolk

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 8.55±0.12 | 8.64±0.13 |
| | V% | 8.01 | 8.45 |
| | Significance of differences | battery vs. loft: F=0.62<F5%=4.006 NS | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 8.75±0.09 | 8.82±0.10 |
| | V% | 6.21 | 6.57 |
| | Significance of differences | battery vs. loft: F=0.51<F5%=4.006 NS | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 9.00±0.16 | 9.10±0.16 |
| | V% | 9.93 | 10.12 |
| | Significance of differences | battery vs. loft: F=0.53<F5%=4.006 NS | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 9.69±0.18 | 9.80±0.19 |
| | V% | 10.49 | 11.11 |
| | Significance of differences | battery vs. loft: F=.054<F5%=4.006 NS | |

Table 2 Protein quantity (g) from yolk

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 2.53 ± 0.02 | 2.56 ± 0.03 |
| | V% | 4.33 | 6.07 |
| | Significance of differences | battery vs. loft: F=0.42<F5%=4.006 NS | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 2.58 ± 0.02 | 2.61 ± 0.04 |
| | V% | 4.98 | 7.61 |
| | Significance of differences | battery vs. loft: F=0.39<F5%=4.006 NS | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 2.66 ± 0.03 | 2.70 ± 0.02 |
| | V% | 5.79 | 4.82 |
| | Significance of differences | battery vs. loft: F=0.38<F5%=4.006 NS | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 2.84 ± 0.03 | 2.88 ± 0.02 |
| | V% | 5.91 | 3.33 |
| | Significance of differences | battery vs. loft: F=0.40<F5%=4.006 NS | |

***Lipids from yolk.*** At eggs obtained at beginning of laying, lipids level in yolk was 6.02±0.07 g at the ones laid by hens accommodated in battery and 6.08±0.07 g at the ones reared in loft.

With birds aging, lipids quantity in yolk lightly increase, recorded levels of 6.17±0.10 g (battery) and 6.21±0.11 g (loft) in case of eggs gathered in peak laying period, 6.34±0.08 g and 6.40±0.09 g at the ones provided by the birds which are at the end of plateau laying period, and at the end of laying the recorded values to be 6.85±0.08 g (battery) respectively 6.92±0.09 g (loft).

Character was homogenous, values of variation coefficient being 6.29-9.13% at eggs laid by hens accommodated in battery and 6.42-9.09% at the ones from loft.

Between mean values determined for lipids quantity in yolk weren't founded statistical differences (tab. 3).

Table 3 Lipids quantity (g) from yolk

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 6.02±0.07 | 6.08±0.07 |
| | V% | 6.84 | 6.42 |
| | Significance of differences | battery vs. loft: F=0.22<F5%=4.006 NS | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 6.17±0.10 | 6.21±0.11 |
| | V% | 9.13 | 9.09 |
| | Significance of differences | battery vs. loft: F=0.29<F5%=4.006 NS | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 6.34±0.08 | 6.40±0.09 |
| | V% | 7.59 | 8.09 |
| | Significance of differences | battery vs. loft: F=0.35<F5%=4.006 NS | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 6.85±0.08 | 6.92±0.09 |
| | V% | 6.29 | 7.37 |
| | Significance of differences | battery vs. loft: F=0.30<F5%=4.006 NS | |

***Dry matter from albumen.*** For eggs laid by hens reared in battery, quantity of dry matter from albumen varied between 4.25±0.11 g as it was at the beginning of laying (week 20 of birds life) and 4.10±0.10 g as was determined at the end of it (week 60).

At eggs gathered from shelter equipped with loft the founded values for dry matter oscillated between 4.26±0.10 g (start of laying) and 4.12±0.09 g (end of laying).

Statistically speaking, between those two egg batches weren't observed significant differences.

The analysed character presented a weaker homogeneity, values for variation coefficient being 11.74-14.08% at eggs gathered from hens in battery and 10.98-13.52% at the ones from loft (tab. 4).

Table 4 Dry matter quantity (g) from albumen

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 4.25 ± 0.11 | 4.26 ± 0.10 |
| | V% | 13.90 | 13.52 |
| | Significance of differences | battery vs. loft: F=0.22<F5%=4.006 NS | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 4.18 ± 0.09 | 4.20 ± 0.08 |
| | V% | 11.74 | 10.98 |
| | Significance of differences | battery vs. loft: F=0.24<F5%=4.006 NS | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 4.14 ± 0.10 | 4.17 ± 0.09 |
| | V% | 13.67 | 13.01 |
| | Significance of differences | battery vs. loft: F=0.28<F5%=4.006 NS | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 4.10 ± 0.10 | 4.12 ± 0.09 |
| | V% | 14.08 | 13.42 |
| | Significance of differences | battery vs. loft: F=0.25<F5%=4.006 NS | |

***Proteins from albumen.*** Those ones kept at quite constant levels during our investigation period, which can be also observed in the missing of statistical differences between batches.

At batch formed by hens reared in battery, proteins from albumen were in quantities of 3.44±0.05 g at the beginning of laying, 3.46±0.05 g in peak of laying, 3.47±0.06 g at the end of plateau period and 3.49±0.06 g at the end of laying.

For the eggs laid by the hens accommodated in loft, protein quantities from albumen were 3.45±0.05 g, 3.48±0.04 g, 3.49±0.05 g respectively 3.50±0.06 g.

Character was homogenous, values of variation coefficient being below 10% (V%=7.83-9.15 at hens from battery and V%=7.59-9.02 at the ones from loft) (tab. 5).

***Mineral substances from shell.*** Birds reared in shelter equipped with battery laid eggs with shell characterized by a mineral content between 5.10±0.16 g (start of laying) and 8.09±0.27 g (end of laying) (V%=14.27-18.40), and at the ones from loft between 5.28±0.18 g (start of laying) and 8.31±0.30 g (end of laying) (V%=15.66-19.83).

Between those two egg batches were identified significant statistical differences at each control stage (tab. 6).

Table 5 Protein quantity (g) from albumen

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 3.44±0.05 | 3.45±0.05 |
| | V% | 8.24 | 8.66 |
| | Significance of differences | battery vs. loft: F=0.11<F5%=4.006 NS | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 3.46±0.05 | 3.48±0.04 |
| | V% | 7.83 | 7.59 |
| | Significance of differences | battery vs. loft: F=0.12<F5%=4.006 NS | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 3.47±0.06 | 3.49±0.05 |
| | V% | 8.84 | 8.70 |
| | Significance of differences | battery vs. loft: F=0.11<F5%=4.006 NS | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 3.49±0.06 | 3.50±0.06 |
| | V% | 9.15 | 9.02 |
| | Significance of differences | battery vs. loft: F=0.05<F5%=4.006 NS | |

Table 6 Mineral substances content (g) from eggs shell

| Control period | Statistical estimators (n=30) | Rearing system | |
|---|---|---|---|
| | | battery | loft |
| Start of laying (week 20) | $\bar{X} \pm s_{\bar{x}}$ (g) | 5.10 ± 0.16 | 5.28 ± 0.18 |
| | V% | 17.84 | 19.26 |
| | Significance of differences | battery vs. loft: F=4.15>F5%=4.006 * | |
| Peak of laying (week 31) | $\bar{X} \pm s_{\bar{x}}$ (g) | 6.11 ± 0.15 | 6.30 ± 0.18 |
| | V% | 14.27 | 15.66 |
| | Significance of differences | battery vs. loft: F=4.41>F5%=4.006 * | |
| Laying plateau (week 40) | $\bar{X} \pm s_{\bar{x}}$ (g) | 7.65 ± 0.23 | 7.85 ± 0.26 |
| | V% | 16.97 | 18.23 |
| | Significance of differences | battery vs. loft: F=4.62>F5%=4.006 * | |
| End of laying (week 60) | $\bar{X} \pm s_{\bar{x}}$ (g) | 8.09 ± 0.27 | 8.31 ± 0.30 |
| | V% | 18.40 | 19.83 |
| | Significance of differences | battery vs. loft: F=5.02>F5%=4.006 * | |

## CONCLUSIONS

From the data regarding the influence of rearing system on eggs' chemical composition resulted that yolk and albumen didn't presented major differences between those two birds batches, mentioning that a little bit higher levels were recorded at hens reared in loft.

So, mean content of yolk in dry matter was 9.08 g eggs from loft (8.99 g at eggs from battery), and the one for albumen was 4.18 g eggs from loft (4.16 g at eggs from battery).

Eggs obtained from hens accommodated in loft had also a higher content in proteins, both the ones from yolk (2.69 g vs. 2.65 g), as well as the ones from albumen (3.48 g vs. 3.46 g).

Mineral substances from shell of eggs laid by birds reared in loft were founded into a quantity of 6.94 g, and at the ones gathered from battery was 6.73 g, which explain the significant differences between batches.

In conclusion, we could say that loft rearing system for laying hens allows obtaining of eggs with a little bit better chemical content than in case of rearing in battery, an advantage which together with the fact that eggs will receive code 2 (classification after rearing system) permit us to recommend this exploitation variant in aviary units from Romania.

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