STUDY REGARDING CHEMICAL CHARACTERISTICS OF EGGS GATHERED FROM HENS REARED IN SYSTEMS APPROVED BY EUROPEAN UNION

STUDIU CU PRIVIRE LA CARACTERISTICILE CHIMICE ALE OUĂLOR PROVENITE DE LA GĂINI CRESCUTE ÎN SISTEME AGREATE DE UNIUNEA EUROPEANĂ

USTUROI AL.[1], USTUROI M.G.[1], AVARVAREI B.V.[1*], RAŢU Roxana Nicoleta[1], NISTOR C.E.[1], SIMEANU Cristina[1]
[*]Corresponding author e-mail: bogdan_avarvarei@yahoo.com

Abstract. *Analysis of which results are presented in the current paper are part of an ample study in which we focused on the influence of rearing systems on quality of eggs destined to human consumption.*
Regarding water content in yolk, we mention the fact that the highest value was founded at the eggs gathered from hens reared on ground with access to external paddock (56.12±0.006%) while the lowest value was recorded at the eggs gathered from hens reared in battery, 55.02±0.006%.
For dry matter content the obtained mean values were 43.88±0.005% for yolk of the eggs gathered from hens reared on ground with access to external paddock, 44.06±0.004% for the one gathered from hens reared in loft and 44.98±0.004% at the ones reared in battery.
Protein content from albumen recorded a calculated mean value of 12.17±0.032% for hens reared in free-range system. For hens reared in loft, protein content in mélange was 12.12±0.036% with variation limits which oscillated between 11.93% and 12.22%. For the eggs gathered from hens reared in battery, protein level in mélange was 12.21±0.035.
In the case of fat content the calculated mean value for eggs gathered from hens reared on ground with access to external paddock was 10.64±0.045%; 11.18±0.041% for the ones reared in loft and 11.22±0.049% for the eggs gathered from hens reared in battery.
Key words: consumption eggs, rearing systems, chemical composition

Rezumat. *Analizele ale căror rezultate sunt prezentate în lucrarea de faţă fac parte dintr-un studiu amplu în care s-a urmărit influenţa sistemelor de creştere asupra calităţii ouălor destinate consumului uman.*
Referitor la conţinutul de apă din gălbenuş, menţionăm faptul că valoarea cea mai ridicată a fost regăsită în cazul ouălor provenite de la găinile crescute la sol cu acces la padocul exterior (56.12±0.006%) în timp ce valoarea cea mai scăzută s-a înregistrat la ouăle provenite de la găinile crescute în baterie şi anume 55.02±0.006%.
Pentru conţinutul de substanţă uscată valorile medii obţinute au fost de 43.88±0.005% la gălbenuşul ouălor provenite de la găinile crescute la sol cu acces la padocul exterior, de 44.06±0.004% pentru cel provenit de la găinile crescute în

[1]University of Agricultural Sciences and Veterinary Medicine from Iaşi, Romania

volieră şi de 44.98±0.004% la cele crescute în baterie.
Conținutul în proteine din albuş a înregistrat o valoare medie calculată pentru găinile crescute în aer liber de 12.17±0.032%. Pentru găinile crescute în volieră, conținutul proteic din melanj a fost de 12.12±0.036% cu limite de variație ce au oscilat între 11.93% şi 12.22%. Pentru ouăle provenite de la păsările crescute în baterie, nivelul proteic din melanj a fost de 12.21±0.035.
În cazul conținutului în grăsimi valoarea medie calculată pentru ouăle provenite de la găinile crescute la sol cu acces la padocul exterior a fost de 10.64±0.045%, de 11.18±0.041% pentru cele crescute în voliere şi de 11.22±0.049% pentru ouăle provenite de la găinile crescute în baterie.
Cuvinte cheie: ouă de consum, sisteme de creştere, compoziție chimică

INTRODUCTION

Egg consumption at world level knows an ascendant trend in majority of countries, predictions in this way being of 2-5%/an; in the same context, is estimated an increase with 3-8% of egg production destined for consumption, as well as concentration of birds' flocks into units with a great capacity (Windhorst, 2008).

Phenomenon have at base the role of eggs in human nourishment, those ones being considered food products with a high nutritive value and with a high digestibility degree of its components, as well as stimulating for organism's metabolic functions (Mizumote *et al.*, 2008).

Rearing system influence also the birds' behaviour, being affected both productive level, but mainly the quality of obtained eggs (Petek *et al.*, 2009).

Even if, laying hens were reared into battery cages (in shelters with controlled environment) for a long period of time, this type of exploitation was vehemently challenged, especially in the last period, which is why staring with 1 of January 2012, classical rearing cages were banned in avian practice from Europe, in according with an EU directive which regulates the comfort which must be assured to laying hens, adopted in July 1999 (De Reu *et al.*, 2009).

In the alternative rearing systems, batteries with "furnished cages" (improved) have enjoyed many positive appreciations; this type of cage is equipped with elements which allow exteriorization of some birds' natural instincts (hatch for laying, abrasive stripes for claws, perches for rest, sand bath etc); additionally, the floor area per bird significantly increase in comparison with conventional cages (Ferrante *et al.*, 2009).

Even if offer a new rearing system, modified cage must be tested in practice, to certify the fact that this accommodation variant assure a good welfare state for birds, satisfactory egg productions and decreasing of mortality, provide a base for their future development into another rearing system, superior to the known one (Wang *et al.*, 2009).

Another solution for exploitation of hens which produce eggs destined to consumption is the one on a permanent layer, in shelters with controlled environment. Even if this variant assure a superior comfort to birds (presence of

layer, a greater movement freedom, existence of hatches and even perches for rest), the fact that hens are devoid of beneficial influence of external atmospherically factors lead to a less good heath state (Windhorst, 2008).

Technological variant which attracted many followers is the one of rearing in open shelters with access at external paddocks (free range) which fulfills all the welfare demands for birds (Magdelaine *et al.*, 2010).

However also this system is exposed to sanitary-veterinary risks, with unpredictable consequences on birds; another problem is raised by high contamination degree of shell of the eggs obtained into such a system with implications on eggs' sanity.

MATERIAL AND METHOD

Determination of water content.

It was established through oven drying method. In oven, samples were kept at temperature of +60°C, for 36 hours, for drying.

After this first stage, the analyzed samples were removed from oven and let to cool down for 24 hours.

Dried samples were weighted and the obtained data were introduced into mathematical formula for moisture calculus:

$$U_r\ (\%) = [(m_p - m_{p.usc})/m_p]\ x100$$

in which:

U_r = represent relative water content, (%);

m_p = mass of the sample, in grams;

$m_{p,usc.}$ = mass of dried sample, in grams.

Determination of dry matter content.

It was determined by calculus, using the following formula:

$$SU_r\ (\%) = 100(\%) - U_r\ (\%)$$

where:

U_r = represent relative water content, (%);

SU_r = relative dry matter, (%).

Determination of protein content.

It was determined by Kjeldahl method, using the same named system, which is based on the following principle: nitrogen from organic combinations, by heating with concentrated sulphuric acid, in the presence of a catalyser is transformed into ammonium sulphate.

Samples, weighted at ≈1 g, are quantitative transferred in each of those 6 digestion tubes, adding after that 3–4 g from catalyser mix ($CuSO_4$+K_2SO_4) and 25 ml H_2SO_4 96%.

Samples' digestion took place during 210 minutes, time in which the mix of sample+catalyser+reagent reaches successively three levels of temperature, as follows: 120ºC,, 240ºC, respectively 420ºC.

At the end, tubes are removed for cooling down and, before passing to distillation stage, in each ampoule are introduced 20 ml of distillate water.

For each distillation, UDK7 module consumes 50 ml NaOH 33% and 50 ml distillate water.

After cooling, digestion tubes were taken and attached to distillation port. In the capture glass of nitrogenous solution is added 25 ml H_3BO_3 4% and 5 five drops of Tashiro indicator.

In the next stage, solution for capture glass was subjected to titration with H_2SO_4 0.1N, till colour reversed from green to pale pink.

Volume of H_2SO_4 (0.1N) used for titration, as well as the other quantities of utilised reagents were introduced in the following calculus formula:

$$\text{Protein substances (\%)} = [0.0014(V_1-V_2)x6.25/m] \times 100$$

where:
0.0014 = nitrogen quantity (g) afferent to one ml of sulphuric acid 0.1 n;
V_1 = volume of sulphuric acid 0.1 n (ml) existent in capture glass;
V_2 = volume of sodium hydroxide solution 0.1 n (ml);
m = quantity of product utilised for determination (g);
6.25 = quantity of protein substances (g) afferent to one gram of nitrogen.

Determination of fat content.

It was realized through Soxhlet method, using an extraction device Velp Scientific – SER 148 type.

Analyzed samples, each with a mass into interval 2.5–3 g were packed in filter paper sachets and those ones were placed into device's cartridges, and finally attached at 3 extraction columns.

In the pots in which solvent boils was added petroleum ether at 30–60ºC (80 ml/glass) and chips for boiling uniformity In the moment in which starts the boiling of solvent, cartridges were immersed in pots, being kept in this position for around 30 minute, time in which temperature in solvent bath reached 111ºC (Immersion Phase).

In the next stage of the programme with duration of 120 minutes, cartridges with samples are taken off from solvent pots and took place a continuous washing of samples in ether vapours which flows into a closed circuit (Washing Phase).

In this stage, fats from sample, previously solvated in immersion stage, are leaked into extraction pots together with solvent.

After two hours, programme began the recovering phase (Recover Phase), with duration of 30 minutes in which the last residues of fat substances together with solvent are leaked from cartridges into extraction pots and reagent is recovered into a collecting, into a rate of ≈60% from initial quantity.

Extraction pots are removed from device's columns and are placed in oven for a complete drying and for obtaining a constant weight.

Difference between mass of the pots after extraction and their mass before extraction represent the fat quantity extracted from sample.

This quantity is related to sample mass and is expressed in percents, in according with formula:

$$G\ (\%) = [(m_2 - m_1)/m] \times 100$$

in which:
m_2 = final mass of extraction pot, (g);
m_1 = initial mass of extraction pot, (g);
m = mass of sample, (g DM).

RESULTS AND DISCUSSIONS

Results regarding quality chemical indicators of yolk

Regarding water content in yolk, we mention the fact that the highest value was founded in the case of eggs gathered from hens reared on ground with access to external paddock (56.12±0.006%) while the lowest value was recorded at the eggs gathered from hens gathered in battery, 55.02±0.006% (tab. 1).

For dry matter content the obtained mean values were 43.88±0.005% at yolk of eggs gathered from hens reared on ground with access to external paddock, 44.06±0.004% for the one gathered from hens reared in loft and 44.98±0.004% at the ones reared in battery (tab. 1).

Regarding protein level for yolk from the eggs of the hens reared on ground with access to external paddock the mean value was 13.33±0.006%, variation limits oscillating in interval 13.05% and 13.46% (tab. 1).

Studied character presented a very good homogeneity, value of variation coefficient being 0.067% (tab. 1).

Table 1

Crude chemical composition of yolk

Rearing system	n	Specification	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
Eggs from hens reared on ground with access to paddock	30	*Water (%)*	56.12±0.006	0.023	57.81	58.22
		D.M. (%)	43.88±0.005	0.031	41.32	42.19
		Proteins (%)	13.33±0.006	0.128	13.04	13.54
		Fats (%)	26.53±0.019	0.463	26.10	26.92
Eggs from hens reared in loft		*Water (%)*	55.94±0.002	0.082	55.11	56.31
		D.M. (%)	44.06±0.004	0.028	43.62	44.68
		Proteins (%)	13.46±0.003	0.067	13.05	13.66
		Fats (%)	26.95±0.022	0.472	26.14	27.41
Eggs from hens reared in battery		*Water (%)*	55.02±0.006	0.031	54.80	55.93
		D.M. (%)	44.98±0.004	0.024	44.28	45.26
		Proteins (%)	13.78±0.005	0.071	13.26	13.94
		Fats (%)	27.04±0.046	0.239	26.67	27.33

At yolk of the eggs gathered from hens reared in loft, variation limits for protein level varied between 13.05% and 13.46% mean value being of 13.66±0.003% (tab. 1).

For the last eggs' category, the ones gathered from hens reared in battery was recorded a mean value for protein content of 13.78±0.005% with a minimum value of 13.26% and a maximum one of 13.94% (tab. 1).

Regarding fat content, were highlighted mean values of 26.53±0.019% for yolk provided by first category of eggs, 26.95±0.022% for the yolk provided from eggs gathered from hens reared in loft and 27.04±0.046% for the one gathred from eggs obtained by hens reared in battery (tab. 1).

Results regarding quality chemical indicators of albumen

Albumen is the egg component with the highest water content, so, for the eggs analyzed by us, the highest level was founded at the eggs gathered from hens reared on ground with access to external paddock, 88.15±0.003%, where variation limits were 88.09% and 88.22% (tab. 2).

For the eggs from hens reared in loft obtained mean of water content was 88.03±0.016% and for the ones from hens reared in battery was obtained a mean value of 87.85±0.012% (tab. 2).

Dry matter content had mean values for those there batches of: 11.85±0.003%; 11.97±0.018 and 12.15±0.023% (tab. 2).

Regarding protein content of the eggs gathered from hens reared on ground was recorded a mean value of 11.12±0.023% with variation limits between 10.94% and 11.18% (tab. 2).

Variation coefficient which was 0.431% allows us to rank the character as being a very homogenous one (tab. 2).

Table 2

Crude chemical composition of albumen

Rearing system	n	Specification	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
Eggs from hens reared on ground with access to paddock	30	*Water (%)*	88.15±0.003	0.014	88.09	88.22
		D.M. (%)	11.85±0.003	0.045	11.73	11.92
		Proteins (%)	11.12±0.023	0.361	10.94	11.18
		Fats (%)	0.08±0.003	6.302	0.07	0.08
Eggs from hens reared in loft		*Water (%)*	88.03±0.016	0.034	88.01	88.12
		D.M. (%)	11.97±0.018	0.253	11.90	12.03
		Proteins (%)	11.04±0.005	0.168	10.98	11.08
		Fats (%)	0.08±0.004	4.621	0.07	0.08
Eggs from hens reared in battery		*Water (%)*	87.85±0.012	0.027	87.83	88.06
		D.M. (%)	12.15±0.023	0.429	12.01	12.17
		Proteins (%)	10.93±0.022	0.312	10.71	11.05
		Fats (%)	0.09±0.002	5.935	0.08	0.09

For eggs gathered from hens reared in loft the mean value established for protein content was 11.04±0.005% in conditions of a minimum value of 10.98% and a maximum one of 11.08% (tab. 2).

The last category of eggs, the ones gathered from hens reared in battery, recorded a mean value for protein level of 10.93±0.022% with variation limits between 10.71% and 11.05%, and the value of variation coefficient was 0.238% (very homogenous character) (tab. 2).

The last analyzed chemical indicator was represented by fat content in albumen; for the first egg category was determined a mean value of 0.08±0.003% minimum being 0.07% and a maximum value of 0.08% (tab. 2).

Variation coefficient was 7.207%, defining this character as being very homogenous (tab. 2).

For the eggs gathered from hens reared in loft the level of fat from albumen recorded a mean value of 0.08±0.004% with variation limits of 0.07% and 0.08% (tab. 2).

Also, in this case the character was very homogenous, variation coefficient being 5.734% (tab. 2).

For the last category of eggs, the ones gathered from hens reared in battery was obtained a mean value of 0.09±0.002%, minimum value being 0.08% and the maximum value was 0.09%; character being also very homogenous (V% = 5.935) (tab. 2).

Results regarding quality chemical indicator of mélange

Regarding chemical composition of mélange at the level of water content, this one was 75.63±0.021% for the eggs gathered from hens reared on ground in shelters with access to external paddock (tab. 3).

Variation limits were into interval 75.12% and 75.96% (tab. 3), variation coefficient being 0.153%, fact which shown a very good homogeneity of the parameter (tab. 3).

For the eggs gathered from eggs reared in loft the obtained mean value for water content was 75.34±0.063% and for the ones gathered from hens reared in battery was 74.81±0.072% (tab. 3).

Table 3

Crude chemical composition of mélange

Rearing system	n	Specification	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
Eggs from hens reared on ground with access to paddock	30	*Water (%)*	75.63±0.021	0.172	75.12	75.96
		D.M. (%)	24.37±0.046	0.371	24.02	24.63
		Proteins (%)	12.17±0.032	0.572	12.00	12.28
		Fats (%)	10.64±0.045	1.340	10.46	10.92
Eggs from hens reared in loft		*Water (%)*	75.34±0.063	0.122	75.02	75.37
		D.M. (%)	24.66±0.023	0.298	24.24	24.95
		Proteins (%)	12.12±0.036	0.632	11.93	12.22
		Fats (%)	11.18±0.041	1.139	11.02	11.41
Eggs from hens reared in battery		*Water (%)*	74.81±0.072	0.194	74.32	75.16
		D.M. (%)	25.19±0.083	0.769	24.92	25.41
		Proteins (%)	12.21±0.035	1.718	11.89	12.45
		Fats (%)	11.22±0.025	0.832	11.02	11.46

Regarding dry matter content the mean values were of 24.37±0.046% for the first category of eggs, 24.66±0.023% for the mélange of eggs gathered from hens in loft and 25.19±0.083% at the mélange of eggs gathered from hens reared in battery (tab. 3).

Studied character presented a good homogeneity, value of variation coefficient being into interval 0.298% and 0.769% (tab. 3).

Protein content from albumen recorded a calculated mean value of 12.17±0.032% for hens reared in open air with a minimum of 12.00% and a maximum value of 12.28% (tab. 3).

Regarding studied character this one presented a very good homogeneity, value of variation coefficient being at a level 0.572% (tab. 3).

For hens reared in loft, protein content from mélange was of 12.12±0.036% with variation limits which oscillated between 11.93% and 12.22% (tab. 3).

The studied character presented also in this case a very good homogeneity, value of variation coefficient being of 0.632% (tab. 3).

For eggs gathered from birds reared in battery, protein level in mélange was of 12.21±0.035% minimum being 11.89% and maximum value being 12.45%; value of variation coefficient was 1.718% showing a very good homogeneity of

the character (tab. 3).

For fat content the calculated mean value for eggs gathered from hens reared on ground with access at external paddock was 10.64±0.045%; 11.18±0.041% for the ones reared in loft and 11.22±0.049% for the eggs gathered from hens reared in battery (tab. 3).

In all three cases character was a very homogenous one, variation coefficients being of 1.340%; 1.139%, and respectively 0.832% in case of eggs gathered from hens reared in battery (tab. 3).

CONCLUSIONS

1. Regarding water content in yolk, we mention the fact the highest value was obtained in the case of eggs gathered from hens reared on ground with access of at external paddock (56.12±0.006%) while the lowest value was recorded at the eggs gathered from hens reared in battery, namely 55.02±0.006%.

2. For dry matter content the obtained mean values were 43.88±0.005% for yolk of eggs gathered from hens reared on ground with access to external paddock, 44.06±0.004% for yolk of eggs gathered from hens reared in loft and 44.98±0.004% for yolk of the eggs from hens reared in battery.

3. Regarding protein level for yolk from the eggs of the hens reared on ground with access to external paddock the mean value was 13.33±0.006%, variation limits oscillating in interval 13.05% and 13.46%.

Studied character presented a very good homogeneity, value of variation coefficient being 0.067%.

At yolk of the eggs gathered from hens reared in loft, variation limits for protein level varied between 13.05% and 13.46% mean value being of 13.66±0.003%.

For the last eggs' category, the ones gathered from hens reared in battery was recorded a mean value for protein content of 13.78±0.005% with a minimum value of 13.26% and a maximum one of 13.94%.

4. Regarding fat content, were highlighted mean values of 26.53±0.019% for yolk provided by first category of eggs, 26.95±0.022% for the yolk provided from eggs gathered from hens reared in loft and 27.04±0.046% for the one gathred from eggs obtained by hens reared in battery.

5. Albumen is the egg component with the highest water content, so, for the eggs analyzed by us, the highest level was founded at the eggs gathered from hens reared on ground with access to external paddock, 88.15±0.003%, where variation limits were 88.09% and 88.22%.

For the eggs from hens reared in loft obtained mean of water content was 88.03±0.016% and for the ones from hens reared in battery was obtained a mean value of 87.85±0.012%.

6. Dry matter content had mean values for those there batches of: 11.85±0.003%; 11.97±0.018 and 12.15±0.023%.

7. Regarding protein content of the eggs gathered from hens reared on

ground was recorded a mean value of 11.12±0.023%.

For eggs gathered from hens reared in loft the mean value established for protein content was 11.04±0.005%.

The last category of eggs, the ones gathered from hens reared in battery, recorded a mean value for protein level of 10.93±0.022%.

8. The last analyzed chemical indicator was represented by fat content in albumen; for the first egg category was determined a mean value of 0.08±0.003%.

For the eggs gathered from hens reared in loft the level of fat from albumen recorded a mean value of 0.08±0.004%.

For the last category of eggs, the ones gathered from hens reared in battery were obtained a mean value of 0.09±0.002%.

9. Regarding chemical composition of mélange at the level of water content, this one was 75.63±0.021% for the eggs gathered from hens reared on ground in shelters with access to external paddock.

For the eggs gathered from eggs reared in loft the obtained mean value for water content was 75.34±0.063% and for the ones gathered from hens reared in battery was 74.81±0.072%.

10. Regarding dry matter content the mean values were of 24.37±0.046% for the first category of eggs, 24.66±0.023% for the mélange of eggs gathered from hens in loft and 25.19±0.083% at the mélange of eggs gathered from hens reared in battery.

11. Protein content from albumen recorded a calculated mean value of 12.17±0.032% for hens reared in open air.

For hens reared in loft, protein content from mélange was of 12.12±0.036% with variation limits which oscillated between 11.93% and 12.22%.

For eggs gathered from birds reared in battery, protein level in mélange was of 12.21±0.035%.

12. For fat content the calculated mean value for eggs gathered from hens reared on ground with access at external paddock was 10.64±0.045%; 11.18±0.041% for the ones reared in loft and 11.22±0.049% for the eggs gathered from hens reared in battery.

REFERENCES

1. **De Reu K., Maertens G., Messens W., Reybroeck W., Ooghe S., Herman L., Daeseleire E., 2009 -** *A market study on the quality of eggs from different housing systems.* Conference proceeding on XIXth European Symposium on the Quality of Poultry Meat and XIIIth Symposium on the Quality of Eggs and Eggs Products. Finland.
2. **Ferrante V., Lolli S., Vezzoli G., Cavalchini L.G., 2009 -** *Effects of two different rearing sistems (organic and barn) on production performance. animal welfare traits and egg quality characteristics in laying hens*. Ital. J. Anim.Sci., 8, p. 165-174.
3. **Magdelaine P., Riffard C., Berlier C., 2010 -** *Comparative survey of the organic poultry production in the European Union.* Proceedings of the XIIIth European Poultry Conference. 66 supplement, S32, p. 1-9, Tours, France.
4. **Mizumote E.M., Canniatti-Brazaca S.G., Machado F.M.V.F., 2008 -** *Chemical and*

sensorial evaluation of eggs obtained by different production systems. Ciencia e Tecnologia de Alimentos, 28, p. 60-65.

5 Petek M., Alpay F., Gezen S.S., Cibik R., 2009 - *Effects of housing system and age on early stage egg production and quality in commercial laying hens.* Kafkas Univ. Vet. Fak. Derg., 15, p. 57-62.

6. Wang X.L., Zheng J.X., Ning Z.H., Qu L.J., Xu G.Y., Yang N., 2009 - *Laying performance and egg quality of blue-shell layers as affected by different housing systems*. Poultry Sci., 88. p. 1485-1492.

7. Windhorst H.W., 2008 - *A projection of the regional development of egg production until 2015*. IEC special report April 2008. International Egg Commission. London.