

RESEARCH ON CHEMICAL COMPOSITION OF CHICKEN EGG FROM DIFFERENT SYSTEMS OF PRODUCTION (CONVENTIONAL AND ORGANIC)

Maria Bologna^{1*}, I.M. Pop¹, Aida Albu¹

¹University of Agricultural Sciences and Veterinary Medicine Iasi, Romania

Abstract

The aim of this study was the comparative analysis of the chemical composition determined for 30 samples of eggs (white, yolk, mixture) from hens of Lohmann Brown Classic breed in their first production cycle. Research has been organized in two units in Romania with different systems of hen egg production (conventional and organic). Determination of gross chemical composition using specific methods in order to standards and regulations in force. Statistical analysis, revealed significant differences between the mean values calculated for white, yolk, mixture samples derived from conventional system compared with the ecological one for crude protein content, SEN, calcium, magnesium, sodium and zinc only in egg white samples and egg mixture; significant for dry matter in samples of egg white, zinc in yolk samples and phosphorous in egg mixture samples. Significant differences were recorded for crude ash content to white, yolk, mixture and crude fat content and phosphorous in samples of albumen.

Key words: chicken egg, chemical composition, organic egg, conventional egg

INTRODUCTION

The egg represent an important source of energy, protein and other nutrients for humans and their rational consumption stimulates the metabolic functions in the body and increases resistance to disease [9] be also an excellent source of vitamins and minerals, especially phosphorus digestible and iron [7].

Properly feeding of poultry is the most important link technology which ensures poultry health. the quality and healthiness of livestock products [3].

In accordance with the rules of the livestock production, "the farm must be bio from producer to consumer". All the ingredients from structure of the foddors for poultry bio must be produced by the rules of organic farming, which must be certified by an inspection body and certification system [12].

MATERIAL AND METHOD

To achieve the objectives. the chemical composition was determined for 30 samples of eggs (albumen, yolk, mixture) coming from hens of Lohmann Brown Classic breed

in their first production cycle. Research has been organized in two units from Romania with different systems of hen egg production (conventional - the vertical storied cages batteries located in Galati County and ecological - with access to green space. located in Cluj County). Hens have been fed with mixed feed which containing similar ingredients, except for chemical synthesis and animal origin which are not allowed in organic production.

The 30 egg samples are samples of albumen, yolk and mixture taken from the two exploitation systems.

The preparation of samples for analysis was made in accordance with the American standards [10]: separating egg white of egg yolk and mixture samples.

Determination of moisture content and dry matter of the samples was made in accordance with current standards [10] by drying in oven kept at a temperature of 105°C for 6 hours to analyze the product ampoules, weighed. Drying operation was repeated until constant weight has been reached.

The content of crude ash was determined in accordance to AOAC, 1990 [10] by calcination of the sample at a temperature of 550°C until constant weight, using the furnace SUPERTERM 611.06 STC model.

*Corresponding author: mary_shoa@yahoo.com
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The content of crude protein was determined by Kjeldahl method (mineralization, distillation, titration) described in ISO 59836-1:2006 / AC: 2009 [15].

Determination of crude fat was made by extraction with organic solvents (petroleum ether) using Soxhlet method in accordance with the technical book Velp [11].

Determination of nutritional parameters (DM%, Ash%, PC%, FC%) helped to achieve the mathematical calculation of organic and extractive substances neazotate.

Expression of the chemical composition of samples was made by relating all parameters analyzed at 100% DM.

The concentrations of P, Ca, Mg, Na and Zn total eggs samples was determined using of atomic absorption spectrometry method in accordance with SR EN ISO 6869:2001 [13] for P, Ca, Mg, Na and in accordance with SR EN 14082:2003 [14] for Zn. Measuring the absorbances was made at UVmini-1240 SHIMADZU spectrophotometer to a wavelength for: P - $\lambda = 430$ nm; Ca - $\lambda =$

422.7 nm; Mg - $\lambda = 285.2$ nm; Na - $\lambda = 589$ nm, Zn - $\lambda = 213.9$ nm in comparison with the reference solution. The concentrations of minerals were expressed as mg/100g fresh produce, were calculated according to the weight of the sample and dilutions, made.

The results of analyzes were processed statistically by calculating the position and variation estimators (arithmetic average \bar{x} , respective the variance S^2 , standard deviation s , standard deviation of average $S_{\bar{x}}$ and coefficient of variation $V\%$) and the significance of differences was determined using Fisher Test.

RESULTS AND DISCUSSIONS

The analysis of average values of gross chemical composition (organic and mineral constituents) obtained from analyzes performed on the 30 samples taken in the study, the calculated value and table value for \hat{F} are shown in tables 1, 2, 3.

Table 1 The average gross chemical composition of the albumen

SPECIFICATION		n ⁷	$\bar{X} \pm s_{\bar{x}}$	s	V%	Limits		FISHER Test	
						Min.	Max.		
DM% ¹	Conv.	5	11.33±0.16	0.36	3.26	10.9	11.8	$\hat{F} = 8.48 > F_{5\%} = 5.32$ ***	
	Eco.	5	12.07±0.19	0.43	3.60	11.32	12.37		
ORGANIC CONSTITUENTS	Ash % ²	Conv.	5	5.99±0.09	0.22	3.67	5.66	6.2	$\hat{F} = 3.76 < F_{5\%} = 5.32$ i.d. ⁸
		Eco.	5	5.66±0.13	0.30	5.46	5.2	5.96	
	OM% ³	Conv.	5	92.35±0.36	0.81	0.88	91.93	93.8	$\hat{F} = 17.85 > F_{1\%} = 11.26$ ** ¹⁰
		Eco.	5	93.91±0.07	0.15	0.16	93.66	94.04	
	PC% ⁴	Conv.	5	92.39±0.16	0.35	0.38	91.99	92.8	$\hat{F} = 395.80 > F_{0.1\%} = 25.42$ *** ⁹
		Eco.	5	87.49±0.18	0.41	0.47	87.1	87.96	
FC% ⁵	Conv.	5	0.002±0.002	0.004	223.60	0	0.01	$\hat{F} = 1 < F_{5\%} = 5.32$ i.d.	
	Eco.	5	0±0	0	0	0	0		
SEN% ⁶	Conv.	5	0.94±0.01	0.04	4.64	0.88	0.99	$\hat{F} = 6864.36 > F_{0.1\%} = 25.42$ ***	
	Eco.	5	5.94±0.05	0.12	2.14	5.75	6.08		
MINERALS	P mg/100g	Conv.	5	10.38±0.22	0.51	4.93	9.56	10.89	$\hat{F} = 4.81 < F_{5\%} = 5.32$ i.d.
		Eco.	5	11.12±0.24	0.54	4.92	10.20	11.66	
	Ca mg/100g	Conv.	5	5.86±0.16	0.37	6.39	5.20	6.09	$\hat{F} = 123.77 > F_{0.1\%} = 25.42$ ***
		Eco.	5	3.50±0.13	0.29	8.31	3.20	3.90	
	Mg mg/100g	Conv.	5	5.48±0.23	0.52	9.47	4.80	5.91	$\hat{F} = 102.36 > F_{0.1\%} = 25.42$ ***
		Eco.	5	3.07±0.05	0.11	3.87	2.93	3.23	
	Na mg/100g	Conv.	5	197.85±0.33	0.75	0.38	196.66	198.42	$\hat{F} = 63586.86 > F_{0.1\%} = 25.42$ ***
		Eco.	5	95.77±0.22	0.50	0.52	95.12	96.21	
	Zn mg/100g	Conv.	5	0.22±0.02	0.06	28.81	0.12	0.28	$\hat{F} = 141.70 > F_{0.1\%} = 25.42$ ***
		Eco.	5	0.60±0.01	0.03	5.83	0.56	0.65	

Table 2 The average gross chemical composition of the yolk

SPECIFICATION		n ⁷	$\bar{X} \pm s_{\bar{x}}$	s	V%	Limits		FISHER Test		
						Min.	Max.			
DM% ¹	Conv.	5	45.06±0.06	0.14	0.31	44.87	45.25	$\hat{F} = 49.23 > F_{0.1\%} = 25.42$ *** ⁹		
	Eco.	5	46.02±0.12	0.26	0.58	45.56	46.22			
ORGANIC CONSTITUENTS	Ash% ²	Conv.	5	3.33±0.12	0.27	8.23	3.03	3.72	$\hat{F} = 0.10 < F_{5\%} = 238.9$ i.d. ⁸	
		Eco.	5	3.27±0.10	0.24	7.45	2.96	3.56		
	OM% ³	Conv.	5	95.49±0.22	0.49	0.52	95.06	96.28	$\hat{F} = 10.0 > F_{5\%} = 5.32$ * ¹¹	
		Eco.	5	96.25±0.09	0.21	0.21	95.93	96.44		
	PC% ⁴	Conv.	5	38.98±0.04	0.09	0.24	38.86	39.1	$\hat{F} = 1512.16 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	35.29±0.08	0.18	0.53	35.06	35.55		
	FC% ⁵	Conv.	5	56.97±0.03	0.07	0.13	56.87	57.06	$\hat{F} = 172.15 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	58.3±0.09	0.21	0.36	58.03	58.56		
	SEN% ⁶	Conv.	5	0.11±0.003	0.007	7.08	56.87	57.06	$\hat{F} = 959 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	2.13±0.06	0.14	6.83	1.96	2.33		
	MINERALS	P mg/100g	Conv.	5	512.03±0.02	0.06	0.01	511.95	512.11	$\hat{F} = 25162.69 > F_{0.1\%} = 25.42$ ***
			Eco.	5	480.96±0.19	0.43	0.09	480.20	481.22	
Ca mg/100g		Conv.	5	118.43±0.10	0.23	0.19	118.13	118.63	$\hat{F} = 403.11 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	122.29±0.16	0.35	0.29	121.94	122.78		
Mg mg/100g		Conv.	5	20.94±0.26	0.58	2.80	19.91	21.33	$\hat{F} = 4973.23 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	41.25±0.11	0.26	0.64	40.98	41.53		
Na mg/100g		Conv.	5	73.23±0.07	0.16	0.21	73.03	73.41	$\hat{F} = 39098.23 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	107.15±0.15	0.34	0.32	106.66	107.51		
Zn mg/100g		Conv.	5	4.59±0.13	0.30	6.62	4.23	4.90	$\hat{F} = 7.83 > F_{5\%} = 5.32$ *	
		Eco.	5	5.0±0.05	0.11	2.31	4.84	5.12		

Table 3 The average gross chemical composition of the mixture

SPECIFICATION		n ⁷	$\bar{X} \pm s_{\bar{x}}$	s	V%	Limits		FISHER Test		
						Min.	Max.			
DM% ¹	Conv.	5	23.00±0.06	0.13	0.59	22.82	23.14	$\hat{F} = 108.63 > F_{0.1\%} = 25.42$ *** ⁹		
	Eco.	5	23.90±0.06	0.13	0.57	23.69	24.03			
ORGANIC CONSTITUENTS	Ash% ²	Conv.	5	3.53±0.14	0.32	9.14	3.12	3.84	$\hat{F} = 0.02 < F_{5\%} = 238.9$ i.d. ⁸	
		Eco.	5	3.55±0.10	0.23	6.58	3.26	3.89		
	OM% ³	Conv.	5	95.96±0.09	0.22	0.23	95.6	96.16	$\hat{F} = 0.007 < F_{5\%} = 238.9$ i.d.	
		Eco.	5	95.97±0.06	0.13	0.14	95.78	96.11		
	PC% ⁴	Conv.	5	50.06±0.04	0.10	0.21	47.94	50.2	$\hat{F} = 1432.38 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	53.26±0.06	0.15	0.29	53.06	53.42		
	FC% ⁵	Conv.	5	36.18±0.04	0.10	0.28	36.08	36.3	$\hat{F} = 123.87 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	35.1±0.08	0.19	0.54	34.86	35.32		
	SEN% ⁶	Conv.	5	9.14±0.23	0.51	5.63	8.46	9.66	$\hat{F} = 62.26 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	7.22±0.07	0.16	2.34	6.96	7.37		
	MINERALS	P mg/100g	Conv.	5	173.58±0.08	0.19	0.11	173.26	173.77	$\hat{F} = 7.93 > F_{5\%} = 5.32$ * ¹¹
			Eco.	5	158.17±5.47	12.23	7.73	136.29	163.80	
Ca mg/100g		Conv.	5	44.16±0.06	0.15	0.35	43.95	44.35	$\hat{F} = 2521.12 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	48.09±0.03	0.07	0.16	47.95	48.15		
Mg mg/100g		Conv.	5	34.06±0.06	0.14	0.41	33.89	34.25	$\hat{F} = 48987.05 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	7.69±0.10	0.22	2.92	7.42	7.94		
Na mg/100g		Conv.	5	173.25±0.05	0.12	0.07	173.09	173.38	$\hat{F} = 249593.22 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	323.29±0.29	0.65	0.20	322.56	323.93		
Zn mg/100g		Conv.	5	2.16±0.03	0.06	3.13	2.06	2.23	$\hat{F} = 453.14 > F_{0.1\%} = 25.42$ ***	
		Eco.	5	1.36±0.02	0.05	3.72	1.29	1.41		

¹DM%= dry matter; ²Ash%= crude ash; ³OM%= organic matter; ⁴PC%= crude protein; ⁵FC%= crude fat; ⁶SEN%= extractive substances neazotate; ⁷n= number of observations from a sample; ⁸i.d. - insignificant differences; ⁹*** - very significant differences; ¹⁰** - significant distinctly differences; ¹¹* - significant differences [8].

From the submitted data can be seen that the statistical analysis resulted very significant differences between average values calculated for samples of white, yolk and mixture, taken from the conventional compared to the ecological for crude protein content (92.39 vs. 87.49%PC – white, 38.98 vs. 35.29%PC – yolk, 50.06 vs. 53.26%PC - mixture), SEN (0.94 vs. 5.94%SEN – white, 0.11 vs. 2.13%SEN – yolk, 9.14 vs. 7.22%SEN - mixture), calcium (5.86 vs. 3.50%Ca – white, 118.43 vs. 122.29%Ca – yolk, 44.16 vs. 48.09%Ca - mixture), magnesium (5.48 vs. 3.07%Mg – white, 20.94 vs. 41.25%Mg – yolk, 34.06 vs. 7.69%Mg - mixture), sodium (197.85 vs. 95.77%Na – white, 73.23 vs. 107.15%Na – yolk, 173.25 vs. 323.29%Na - mixture) and respective zinc only for albumen samples (0.22 vs. 0.60 %Zn) and mixture (2.16 vs. 1.36%Zn); significant differences were recorded for the dry matter content of albumen samples (11.33 vs. 12.07%DM), the zinc content in yolk samples (4.59 vs. 5%Zn) and respective phosphorus for mixture samples (173.58 vs. 158.17%P).

Insignificant differences were recorded for crude ash in whites (5.99 vs. 5.66%Ash), yolk (3.33 vs. 3.27% Ash.), mixture (3.53 vs. 3.55% Ash) and the content in crude fat (0.002 vs. 0%FC) and phosphorus (10.38 vs. 11.12%P) in albumen samples.

Results of own research compared to data generated in other studies carried out in the country and abroad are presented in table 4.

From the analysis the average values of own results of research was noticed that the value of dry matter for albumen samples, 11.33%DM and yolk, 45.06%DM from conventional and ecological system (12.07%DM, 46.02%DM), were below the limit interval found in other research (12.7%DM, 50.8% DM – albumen, yolk conventional and 51.1%SU – ecological yolk) [7, 1], and for mixture samples from the conventional (23% DM) and ecological (23.90% DM) falling within the range found in other research (21.69% DM, 26.9% DM) [7, 1, 2].

As regards average values for the quantity of crude ash for albumen samples

from the conventional (5.99%Ash), have seen that the value is above the limits found in other research, 4.7%Ash [1], for yolk samples conventional and organic (3.33%Ash, 3.27%Ash) are above the limits found in the bibliography, 2.4% Ash and 1.61% Ash, and for mixture samples of the conventional and organic average values, 3.53%Ash and 3.55%Ash is below the interval found in other research (4.59%Ash and 4.43%Ash)[4].

For the value organic matter content was seen that the average found for samples of conventional and ecological system (92.35 ÷95.96%OM and 93.91 ÷96.25%OM) were within between margins found in the literature (95.3÷97.6%OM) [1].

As regards average values for crude protein content for albumen samples taken from the conventional (92.39%PC) are below the limit found in the literature (97.4%PC) [1], and the yolk and mixture samples from conventional and ecological system average values (38.98÷53.26% PC) are over limits found in the other research (12.10÷32.5%PC) [1, 2].

And for crude fat values found in the own research for albumen samples taken from the conventional (0.002%FC) are under the limit found in the literature (4.4% FC) [1], for yolk samples from the conventional average values (56.97% FC) are under the limits the average values found in the other research (64.2% FC) [1] and average values 58.3% FC higher for organic yolk (31% FC) and for mixture samples of both systems average values (36.18% FC and 35.1% FC) is below the limits found in other research for conventional mixture (44.2% FC) [1] and above the limits from bibliographic sources for organic mixture (5.85% FC) [2].

The average values for extractive substances neazotată found in own research for samples of conventional system (0.11÷0.94%SEN) is under the limits found in the literature for albumen and yolk (3.5 and 9%SEN) [1].

Table 4 The average gross chemical composition of hen egg by different authors

Speci- fication	Prove- nance	DM%	Constituents % from DM					Mineral constituents mg/100g fresh produce					Source
			Ash	OM	PC	FC	SEN	P	Ca	Mg	Na	Zn	
Albumen	Conv.	n/a ¹	n/a	n/a	n/a	n/a	n/a	18	8	100	155	0.12	Nys and Sauveur,2004
	Conv.	12.7	4.7	95.3	97.4	4.4	3.5	n/a	n/a	n/a	n/a	n/a	Burlacu, 2002
	Eco.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Yolk	Conv.	50.7	1.63	n/a	16.7	31.0	n/a	n/a	n/a	n/a	n/a	n/a	Minelli et al., 2007
	Eco.	51.1	1.61	n/a	17.1	31.0	n/a	n/a	n/a	n/a	n/a	n/a	Burlacu, 2002
	Conv.	50.8	2.4	97.6	32.5	64.2	9.0	n/a	n/a	n/a	n/a	n/a	Nys and Sauveur, 2004
	Conv.	n/a	n/a	n/a	n/a	n/a	n/a	530	133	15	50	3.9	
Mixture	Conv.	23.15±0.23	0.91± 0.03	n/a	n/a	8.88±0.44	n/a	173	38.2	n/a	134±20	n/a	Minelli et al., 2007
	Eco.	22.6± 0.23	0.89± 0.03	n/a	n/a	7.94±0.4	n/a	164	13.6	n/a	131±20	n/a	
	Conv.	26.9	2.8	97.2	47.9	44.2	5.6	n/a	n/a	n/a	n/a	n/a	Burlacu, 2002
	Conv.	n/a	n/a	n/a	n/a	n/a	n/a	193	50	12	120	1.3	Nys and Sauveur, 2004
	Conv.	n/a	4.59	n/a	n/a	n/a	n/a	98	26.33	5.33	n/a	0.06	Matt et al., 2009
	Eco.	n/a	4.43	n/a	n/a	n/a	n/a	57.78	24.60	5.78	n/a	0.0416	
	Conv.	23.53	n/a	n/a	12.55	7.32	n/a	175.50	48.53	8.47	112.12	1.43	Cimpean C. and colab., 2011
Eco.	21.69	n/a	n/a	12.10	5.85	n/a	158.35	42.13	8.84	101.7	2.90		

Concentrations of P, Ca and Mg from samples of albumen (10.38 mg/100g P, 5.86 mg/100g Ca and 5.48 mg/100g Mg) and yolk (512.03 mg/100g P, 118.43 mg/100g Ca and 20.94 mg/100g Mg) from the conventional system showed values under the limits found in the literature (18 mg/100g P, 8 mg/100g Ca and 100 mg/100g Mg – for albumen, 530 mg/100g P, 133 mg/100g Ca – for yolk) [6], except Mg in conventional yolk is above the limit found in the literature (15 mg/100g Mg) [6], and for mixture samples from the conventional and organic concentrations of P and Ca (44.16 mg/100g Ca÷173.58 mg/100g P) falling within the range found in other research (24.60 mg/100g Ca÷193 mg/100g P) [4, 5, 6, 2]. For mixture samples from the conventional and organic concentrations of Mg, Na and Zn the average values (2.16 mg/100g Zn÷323.29 mg/100g Na) results from own research are above the limits found in other research (0.04 mg/100g Zn÷131 mg/100g Na) [6, 5, 4, 2] except the average values of concentrations of Mg (7.69 mg/100g) and Zn (1.36 mg/100g) for organic mixture samples the values are under the limits found in literature studied (8.84 mg/100g Mg and 2.90 mg/100g Zn) [2]. Concentrations of Na (197.85÷73.23mg/100g) and Zn (0.22÷4.59mg/100g) at albumen and yolk samples from the conventional system showed values above the limits found in the literature (50÷155mg/100g Na and 0.12÷3.9mg/100g Zn) [6].

CONCLUSIONS

Results showed that eggs from conventional system had a high crude protein content (both in albumen - 92.39 vs. 87.49 %PC, as well as yolk - 38.98 vs. 35.29 %PC) and crude fat (in mixture – 36.18 vs. 35.1 %FC), correlated with water content, but not with that of minerals. This fact is owed mixed fodder used. Mineral content of egg components were variable:

- at samples taken from the organic system higher concentrations in P were observed to albumen (11.12 mg/100g), while in yolk higher concentrations for Ca (122.29 mg/100g), Mg (41.25 mg/100g), Na (107.15 mg/100g) and Zn (5 mg/100g).

- at samples taken from the conventional higher concentrations of minerals studied were noted in yolk for P (512.03 mg/100g),

Ca (5.86 mg/100g), Mg (5.48 mg/100g) and in albumen for Na (197.85 mg/100g).

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- [14]*** - SR EN ISO 14082:2003 Produse alimentare. Determinarea microelementelor. Determinare plumb, cadmiu, zinc, cupru, fier și crom prin spectrometrie de absorbție atomică (SAA) după calcinare.
- [15] ***- SR EN ISO 5983-1:2006/AC:2009 Nutrețuri. Determinarea conținutului de azot și calculul conținutului de proteină brută. Partea 1: Metoda Kjeldahl.