NUTRITIONAL PECULIARITIES OF THE HEN EGGS PRODUCED WITHIN IMPROVED CAGES OR FREE RANGE ALTERNATIVE SYSTEMS

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Abstract

Since the E.U. regulations on poultry welfare enforced egg producers to migrate from conventional husbandry systems toward the alternative ones, it was interesting to investigate certain chemical and nutritional parameters of the hen eggs produced in the new conditions. 500 Lohmann Brown hens, aged 21 weeks, were randomly allotted 250 in each of the two groups coded IC (improved cages system) and FR (free range system) and fed the same diet. The housing version became the experimental factor which differentiated the populations (800 cm^2/hen in IC group, isolated hall and 9 hens/m^2 in FR + access to an outer paddock). 100 eggs/group were collected, yolks and albumens separated for sampling then re-mixed to assess whole egg traits. Standardized methods were used to analyze chemical composition, caloricity and cholesterol content, then ANOVA single factor served for statistical analysis. Yolk water content was almost similar for both groups, 56.92% vs. 57.01% (IC vs. FR). Main organic compounds of yolk were higher in the eggs laid by IC hens (proteins-13.44%, lipids 25.42%) compared to FR eggs (proteins-13.28%, lipids-25.39%). Therefore, caloricity was slightly lower in free-range originated yolks (330.18 kcal vs. 330.82 kcal per 100 g yolk), as well as the cholesterol level (lower in FR-918.66 mg/100g and slightly higher in IC-921.97 mg/100 g). Per whole edible egg of 60 g, caloricity was somehow identical in groups (between 105 and 106 Kcal) and cholesterol content reached 215.72 mg in IC eggs and 213.16 mg in FR eggs.

Key words: eggs, improved cages, free range, chemical composition, cholesterol

INTRODUCTION

Changes in poultry husbandry technology and housing systems, due to compliance to the fowl welfare requirements, had imposed several studies to be done, in order to know the way in which the usage of a new rearing and exploitation system could affect hens behaviour, the quality of edible poultry products (meat, eggs) and the economic efficiency of production [5], [8].

Speaking of poultry products nutritional quality, for instant eggs issued from alternative production systems, some researchers focused on the proximate composition and nutrients of the eggs. Thus, in free range or cage-free systems, proportion of the yolk was lower than in other systems, which differed mainly through the used diet (vegetarian diet or animal fat included or un-medicated diet), no difference was reported on the total PUFA content of eggs [2]. Another study run on commercial eggs showed that, from nutritional point of view there was found slight significant statistic differences for proteins and saturated fatty acids, but the real variations were minimal, when eggs from conventional cage and alternative productions systems were compared [4]. Other authors stated that through eggs composition elasticity due to hen diet compounds, these products have immense potential to provide consumers nutritional and functional benefits, to maximize the beneficial and preventive potential [6]. Finally a question arises: in order to provide well balanced eggs for consumer needs, what feeding and rearing systems should be used, to better manage all involved influential factors?

The present paper aims to briefly present the findings on the nutritional and dietetic quality of the eggs produced in two EU

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approved alternative housing systems, during the onset of laying period, as part of a greater project that aim to assess the influence of fowl welfare friendly husbandry systems on the quality of poultry meat and table eggs in Romania.

MATERIAL AND METHODS

The biological material was represented by the eggs produced by 500 Lohmann Brown laying hens aged 21 weeks, randomly distributed in two groups: IC group - 250 hens accommodated in furnished cages (800 cm^2/hen, perches and nests inside the cage) and FR group- 250 hens, reared on deep litter, with access to paddock (9 hens/m^2), in order to comply the welfare requirements stipulated in Council dir. 74/1999/EEC, which became compulsory in all EU member states since January 1, 2012 [9].

Hens were fed an adult layer mixed feed diet, based on corn-wheat and soybean meal. Both groups were fed the same diet, in order to avoid any influence of certain different feed nutrients on the ultimate nutritional value of the eggs, knowing that especially quality of lipids in animal products varies in relation to the feed composition.

At the end of 21st week of fowl life, 100 eggs were sampled from each group, in order to run chemical investigations. There have been performed analyses on all edible compounds of the eggs (yolk, albumen, whole egg-melange), in order to identify and quantify the values for the following parameters: water, dry mater, ash, proteins (total nitrogen matters), lipids, nitrogen free extract, gross energy and cholesterol. The eggs from each group have been broken, to separate yolk and albumen and take samples. Then, the remnants were mixed together, in order to assess quality of whole fresh eggs. 20 repetitions (samples) were analyzed for each parameter, for each edible compound, except for cholesterol (5 repetitions). The samples were well labelled, then were weighted and dehydrated at 60°C. The issued powder was used for analytical chemistry assessments, in order to evaluate eggs content in certain nutrients, accordingly to the analytical standards recognized internationally (humidity-SR ISO 1442/1997, mineral substances -SR ISO 936: 1998, total nitrogen and proteins-Kjeldahl direct method for Velp Scientifica-SR ISO 937:2007, lipids-Soxhlet direct method for Velp Scientifica-SR ISO 1443:2008, cholesterol-titrimetric method AOAC 941.09). Nitrogen free extract was calculated through difference, as follows: NFE (%) = Dry Matter % – Minerals % - (Total nitrogen % + Lipids %). Eggs dietetic value was evaluated, besides the cholesterol level, through their caloricity, using the theoretical relation which is based on the quantity of gross energy spread by the burning of 1 g crude protein, crude fat and nitrogen free extract into a calorimeter (GE (Kcal/100g)=5.70Kcal x $n_{\%}$CP + 9.50Kcal x $n_{\%}$CF + 4.2 Kcal x $n_{\%}$NFE).

Most of the parameters were expressed by 100 g edible portion, while some of them, such as cholesterol and caloricity were also recalculated per one table egg (60 g), in order to better depict the nutritional involvements.

Collected data were subjected to statistical computation, using ANOVA single factor algorithm, to find out any significant differences between the studied technological systems of layer husbandry.

RESULTS AND DISCUSSIONS

Analytical results related to chemical composition of the 200 investigated eggs (100 from IC group and 100 from FR group), at the beginning of laying are listed in table 1.

Thus, for yolk composition, water content was slightly higher in FR group (57.01±1.41%), compared to IC group (56.92±1.44%), therefore the dry matter proportion evolved conversely proportional. Minerals were found at 1.17 (FR) – 1.19% (IC), while the organic compounds were more concentrated in the eggs laid in cages vs. free range system (13.44±0.26% vs. 13.28±0.26% for proteins 25.42±0.40% vs. 25.39±0.39%).

For the albumen analytical investigations, there must be specified the high water content (87.92-88.01%) and the low level of lipids, around 0.09% (almost no detectable). Also, the proteins levels were quite high, reaching 11.07-11.1% from raw composition or 91.64-92.56% from the dry matter (DM). Therefore, the albumens of those eggs

produced in the free range system were slightly more concentrated in proteins (+1%), compared to those issued from improved cages. Compared to the yolk proteins content per DM, albumen was found almost three times richer in nitrogen, (30.90- 31.19% proteins in yolk DM).

Table 1 Chemical composition of the eggs, related to the husbandry system of laying hens during laying onset period (fowl aged 21 weeks)

Egg compartment	Chemical compounds (%)	IC group (n=20)			FR group (n=20)		
		$\overline{X}$	$\pm s_{\bar{x}}$	V%	$\overline{X}$	$\pm s_{\bar{x}}$	V%
Yolk	Water	56.92	1.44	11.93	57.01	1.41	11.70
	Dry matter	43.08	1.06	11.57	42.99	1.05	11.57
	Ash	1.19	0.02	7.92	1.17	0.02	7.77
	Proteins	13.44	0.26	9.11	13.28	0.26	9.11
	Lipids	25.42	0.40	7.46	25.39	0.39	7.31
	Nitrogen free extract	3.03	0.05	7.23	3.15	0.05	7.23
Albumen	Water	87.92	2.00	10.76	88.01	1.97	10.56
	Dry matter	12.08	0.28	11.06	11.99	0.28	10.87
	Ash	0.64	0.01	6.32	0.62	0.01	6.20
	Proteins	11.07	0.22	9.19	11.1	0.22	9.19
	Lipids	0.09	0.002	10.09	0.09	0.002	9.90
	Nitrogen free extract	0.28	0.01	9.25	0.18	0.004	9.25
Whole egg, fresh	Water	74.08	0.99	6.34	74.11	0.98	6.23
	Dry matter	25.92	0.35	6.34	25.89	0.35	6.33
	Ash	1.12	0.02	7.95	1.1	0.02	7.81
	Proteins	12.42	0.20	7.49	12.45	0.20	7.48
	Lipids	10.03	0.16	7.37	9.95	0.15	7.24
	Nitrogen free extract	2.35	0.04	8.65	2.39	0.04	8.48

**N.F.E=nitrogen free extract*

One whole fresh egg, weighting 60 g, contained, in average, 74.08% – 74.11% water, 12.42-12.45% proteins and 9.95-10.03% lipids.

Speaking of caloricity, the calculation (table 2) revealed gross energy value of 330.13±6.61 Kcal/100 g yolk (FR) and 330.82±6.92 Kcal/100 g yolk (IC), while albumen energetic value was very low (64.88-65.13 Kcal/100 g). Eating an egg of 60 g would bring the consumer 105.32-105.57 Kcal, thus the technological system applied in laying hens rearing does not affect significantly the chemical composition and, consequently, the caloricity of the eggs, fact proved also by the statistical analysis.

Table 2 Caloricity of the eggs, related to the husbandry system of laying hens during laying onset period (fowl aged 21 weeks)

Caloricity per egg sorts	IC group (n=20)			FR group (n=20)		
	$\overline{X}$	$\pm s_{\bar{x}}$	V%	$\overline{X}$	$\pm s_{\bar{x}}$	V%
Kcal / 100 g yolk	330.82	6.92	9.87	330.13	6.61	9.45
Kcal / 100 g albumen	65.13	1.27	9.18	64.88	1.27	9.21
Kcal / 100 g egg mass	175.95	2.81	7.54	175.53	2.82	7.58
Kcal / whole egg of 60 g	105.57	1.69	7.54	105.32	1.69	7.58

Cholesterol content better complete the nutritional and dietetic image of any aliment, so our analytical findings revealed in yolk levels of 918.66±37.10 mg/100 g (free range eggs) and 921.97±38.26 mg/100 g (cage eggs) (table 3), while in albumen, the nutrient was not detectable.

Table 3 Cholesterol content of the eggs, related to the husbandry system of laying hens during laying onset period (fowl aged 21 weeks)

Cholesterol per egg sorts	IC group (n=5)			FR group (n=5)		
	$\bar{X}$	$\pm s_{\bar{x}}$	V%	$\bar{X}$	$\pm s_{\bar{x}}$	V%
mg / 100 g yolk	921.97	38.26	9.28	918.66	37.10	9.03
mg / 100 g albumen	ND*	-	-	ND	-	-
mg / 100 g egg mass	359.53	14.60	9.08	355.27	14.38	9.05
mg / whole egg of 60 g	215.72	8.76	9.08	213.16	8.63	9.05

*ND-not detectable

For one whole egg (60 g edible product, fresh) cholesterol values oscillated between 213.16±8.63 mg (FR group) and 215.72±8.76 mg (IC group). The statistical analysis also did not highlight any significance of the influence that the rearing system (free range or improved cages) might play in modifying caloricity or cholesterol level in table eggs. Similar situation and close values were reported by other authors [1], [7].

Overall, the variability of all analyzed traits was good, depicting homogeneity for the nutritional and dietetic parameters of table eggs produced within the new EU-approved alternative husbandry systems for laying hens.

Finally, to better depict the nutritional value of the eggs either produced in furnished cages or free range system, we used the Dietary Reference Intake calculator from USDA website [10] to calculate the contribution of such an egg (60 g) the daily dietary needs for humans of certain ages and genders:

- 4.07% from 2583 Kcal energy, 13.31% from 56 g proteins and 7.69% from 78 g lipids, for a man aged 35 years, average body size (height=170 cm, weight= 70 kg) and average active;
- 5.06% from 2083 Kcal energy, 15.52% from 48 g proteins and 9.38% from 64 g lipids, for a woman aged 35 years , non pregnant or lactating, average body size (height=165 cm, weight=60 kg) and average active;
- 4.94% from 2134 Kcal energy, 17.34% from 43 g proteins and 8.57% from 70 g lipids, for a teenager aged 15 years, average body size (height=150 cm, weight=47 kg) and average active.

Although the nutritional needs are partially covered by consuming an egg/day, the DRI calculator recommends cholesterol intake to be as low as possible, while, an adequate diet is followed. Other experts [11] report a daily cholesterol intake of 250-325 mg for men and 180 to 205 mg for women. Thus, consuming daily an egg almost covers the intake for this macronutrient in men (66-86%) and even exceed for women (+4.87-19.84% above the daily tolerable limit), without speaking of cholesterol uptake from other food containing animal originated ingredients. Therefore, although the eggs are complete and high valuable aliments, precaution is needed when consuming them, in order to have a well balanced diet and good health.

The investigations are still continuing, to assess chemical composition and nutritional value of these aliments across the whole productive life of a hybrid laying hen (age of 20-72 weeks). The researches will be completed with fatty acids spectrum studies, knowing that are opinions among that suggests that the lipids profile (ratio ω-3:ω-6 FA) varies with the husbandry system and feeding conditions, mostly when fowl have or not access to pasture and, could lead to exacerbation of pain conditions, cardiovascular disease and probably most cancers [3].

CONCLUSIONS

There were found slight differences between free range eggs and those produced in improved cages, related to chemical composition.

Higher levels of energy and cholesterol, were recorded for the eggs laid by the hens accommodated in furnished cages, although not relevant as difference, compared to free range eggs.

Nutritional and dietetic traits of the hen eggs laid during the laying onset period were not significantly affected by the experimental factor we investigated – two versions of alternative rearing systems.

Daily intake of one 60 g egg cover 7.69-17.34% of the nutritional needs of the consumer in energy, proteins and lipids (depending on gender, age, development, activity level), while the cholesterol dose from such intake exceeds the quotidian upper tolerable limit for women of average physical condition.

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