CONTRIBUTIONS ON THE QUALITY KNOWLEDGE OF THE EGGS LAID BY HENS REARED WITHIN VERSIONS OF PERMANENT LITTER TECHNOLOGICAL SYSTEM

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Abstract

The investigations focused on the establishment of quality for those eggs issued from certain versions of the permanent litter technological system. The biological material comprised 2025 hens belonging to the "Hisex Brown" hybrid, allocated in 2 groups (Lc-permanent litter hall, in an environment controlled compartment; Lexp-rearing on permanent litter, in a compartment opened toward an outer paddock). Quality traits were assessed through conventional methods, using eggs sampled from the 4 main moments of the laying curve (onset, peak, plateau and ceasing). In those birds which acceded to the external paddock (Lexp group), the proportion of eggs with morphologic anomalies was 0.08% lower; moreover, the eggs presented better levels for the quality parameters, which were 1.31% higher for weight, with 5.47% higher for shell thickness, 2.36% higher for shell breaking strength, 0.28% more yolk and 0.36% more shell proportion in whole egg structure. The achieved data indicated that, at least for egg quality, the "free range" was better than the conventional one (isolated houses, permanent litter); that advantage was provided by the free access of the laying hens to the outer environment, which contributed to enhance egg formation processes and better D_3 synthesis, knowing its involvement in the calcium metabolism.

Key words: hybrids, hen, rearing, eggs, quality

INTRODUCTION

Those elements stamped on the table eggs shell define their quality and are represented by weight class and, recently, by a code related to the husbandry technology used in laying hens exploitation [6].

Super-intensive system used in rearing laying hens (in classical batteries), while ensuring the highest eggs yields and chemical properties quite similar to the eggs obtained in other maintenance systems [4], is challenged because it violates the condition of birds welfare, but mostly because it would be responsible for producing so-called "biologically dead eggs", with high stress hormones and other harmful substances [5].

Under these conditions, there were designed and placed in poultry practice new technological solutions for laying hybrid husbandry [3], both from the group of the vertical layout (opened batteries, improved batteries, etc.) [1] and those with horizontal arrangement (on technological shelves, on deep litter, within the "free range" system etc.) [2].

The paper presents the results of a study related to the way in which two versions of the deep permanent litter technology affects the quality of produced eggs.

MATERIAL AND METHOD

The investigated material consisted in 2025 laying hens, "Hisex Brown" commercial hybrid, randomly allocated in 2 groups (Lc and Lexp) which differed by the applied husbandry system and technology (tab. 1), as follows:

- Lc group- intensive husbandry system, deep litter technology, into a environment controlled hall, at a density of 6.0 hens/m^2;
- Lexp-semi-intensive husbandry system (free range), deep litter compartment and free access to the outer paddock; brooding density was 7.5 hens/m^2.

Assessments were run on eggs sampled during 4 different stages of the laying curve: onset (week 20), peak (week 28), plateau (week 38) and ceasing (week 70).

Table 1. Experimental design

Exp. groups	**Lc**	**Lexp**
Exploitation system	intensive	half-intensive
Husbandry technology	Deep litter	Deep litter and access to outer paddock
Compartment area	150 m^2	150 m^2
Brooding flock size	900 hens	1125 hens
Brooding density	6.0 hens/m^2	7.5 hens/m^2
Area/hen	0.167 m^2 /hen	0.133 m^2 /hen

Certain parameters were investigated:

- eggs with morphologic anomalies (%) – identified then reported to the yield from every control period;
- eggs weight (g)-through individual weighting on the electronic scale;
- shell thickness (mm)-average of three assessments (rounded end, sharp end and equatorial area), run on a comparative dial device;
- shell breaking strength (kgf/cm^2)-pressure strength, run on a Schröder device;
- eggs structure (%)-separation of the 3 compounds (albumen, yolk and shell), their weighting and ratio to egg weight.

RESULTS AND DISCUSSIONS

1. Eggs with morphologic anomalies. It represents a category that can not be marketed for direct consumption, but can be used through dehydration (egg-powder). The control carried out at the beginning of lay revealed a higher proportion of eggs with cracked shell (0.61 to 0.65%) and without shell (0.21 to 0.24%) from whole yield. Total morphological abnormalities in group Lc reached 1.09% and 1.06% in Lexp group. Total proportion of eggs with abnormalities decreased during peak laying period (0.81% in group Lc; 0.72% in group Lexp), but began to increase again during laying plateau (1.17% at Lc; 1,12% at Lexp) and especially at the end of laying (2.33% at Lc; 2.31% at Lexp), basing on those eggs with misshaped or shell less eggs (tab. 2).

2. Eggs weight.

At the fowl in the beginning of laying (aged 20 weeks) assessed egg weight was determined at 48.11 ± 0.872 g in group Lc and 48.89 ± 0.958 g in Lexp group. Increase of weight was recorded during the following control stages and also the emergence of differences between groups. Thus, during the peak of laying (28th week), weight of eggs obtained from Lexp group was 58.09 ± 0.566 g, compared to only 57.53 ± 0.532 g in group LC. The plateau in laying hens (38th week) gave eggs weight of 60.96 ± 0.752 g in Lc group and 61.84 ± 0.817 g in Lexp group. The inspection in the 70th week resulted in the highest recorded weight values, of 65.22 ± 0.927 g in group Lc and 66.04 ± 0.942 g in Lexp group. Studied character was homogeneous studied only during laying peak (V% = 9.25 to 9.74), while in other periods middle variability occurred (V% = 12.34 to 19.59) (Table 3).

Table 2. Morphologic anomalies in eggs(%)

Fowl age	Anomaly type (%)	Group	
		Lc	Lexp
Week 20	Misshaped shell eggs	0.15	0.14
	Eggs without yolk	0.02	0.01
	Eggs without shell	0.21	0.24
	Eggs with two yolks	0.06	0.06
	Broken shell eggs	0.65	0.61
	Total	**1.09**	**1.06**
Week 28	Misshaped shell eggs	0.32	0.31
	Eggs without yolk	0.05	0.03
	Eggs without shell	0.09	0.07
	Eggs with two yolks	0.03	0.03
	Broken shell eggs	0.32	0.28
	Total	**0.81**	**0.72**
Week 38	Misshaped shell eggs	0.39	0.36
	Eggs without yolk	0.07	0.04
	Eggs without shell	0.10	0.09
	Eggs with two yolks	0.05	0.04
	Broken shell eggs	0.56	0.59
	Total	**1.17**	**1.12**
Week 70	Misshaped shell eggs	0.51	0.47
	Eggs without yolk	0.15	0.20
	Eggs without shell	0.36	0.35
	Eggs with two yolks	0.04	0.03
	Broken shell eggs	1.27	1.26
	Total	**2.33**	**2.31**

Table 3. Weight (g) of studied eggs

Fowl age	Statistics	Exp. groups	
		Lc	Lexp
Week 20	$\bar{x} \pm s_{\bar{x}}$	48.11 ± 0.872	48.89 ± 0.958
	V%	18.13	19.59
Week 28	$\bar{X} \pm s_{\bar{x}}$	57.53 ± 0.532	58.09 ± 0.566
	V%	9.25	9.74
Week 38	$\bar{X} \pm s_{\bar{x}}$	60.96 ± 0.752	61.84 ± 0.817
	V%	12.34	13.21
Week 70	$\bar{X} \pm s_{\bar{x}}$	65.22 ± 0.927	66.04 ± 0.942
	V%	14.22	14.27

3. Shell thickness is the most variable eggs trait. The achieved data indicates a certain relation between shell thickness, applied husbandry system and Fowl age, also related to calcium metabolism intensity (tab. 4).

Table 4. Eggshell thickness (mm)

Fowl age	Statistics	Exp. groups	
		Lc	Lexp
Week 20	$\bar{X} \pm s_{\bar{x}}$	0.424± 0.012	0.430± 0.011
	V%	15.85	13.97
Week 28	$\bar{X} \pm s_{\bar{x}}$	0.380± 0.010	0.404± 0.009
	V%	14.90	11.78
Week 38	$\bar{X} \pm s_{\bar{x}}$	0.329± 0.010	0.342± 0.008
	V%	16.76	13.91
Week 70	$\bar{X} \pm s_{\bar{x}}$	0.321± 0.013	0.358± 0.011
	V%	22.18	17.45

The highest levels of the shell thickness ranged from 0.358 ± 0.011 mm (end of lay) to 0.430 ± 0.011 mm (beginning of lay) were found in the eggs from birds reared in the "free range" system (group Lexp) because best synthesis of vitamin D3, involved in calcium transport and calcium blood balance. The eggs laid by hens of group Lc (deep litter) presented a shell thickness of 0.321 ± 0.013mm minimum (end of lay) and a maximum of 0.424 ± 0.012 mm (beginning of lay). The character studied was somewhat homogeneous in group Lexp (V% = 11.78 to 17.45) and less homogeneous in Lc group (V% = 14.90 to 22.18).

4. Shell breaking strength. It is a qualitative parameter positively correlated with shell thickness. Determinations showed that at the beginning of laying, it was recorded the highest break resistance level, which was higher in eggs Lexp group (0.343 ± 0.006 kgf/cm^2) and lower in Lc group (0.338 ± 0.010 kgf/cm^2). At the next control period there was a decrease in the values that have defined the breaking strength, the lowest values being between the end of the laying, of 0.326 ± 0.011 kgf/cm^2 in group Lc and 0.334 ±0.007 kgf/cm^2 in group Lexp. Regarding the coefficient of variation, calculated values showed a middle variation in group Lc (V% = 13.13 to 18.07) and a better homogeneity in group Lexp (V% = 6.62 to 11.84) (tab. 5).

Table 5. Shell breaking strength (kg f/cm^2)

Fowl age	Statistics	Exp. groups	
		Lc	Lexp
Week 20	$\bar{X} \pm s_{\bar{x}}$	0.338± 0.010	0.343± 0.006
	V%	16.59	10.71
Week 28	$\bar{X} \pm s_{\bar{x}}$	0.330± 0.008	0.339± 0.004
	V%	13.13	6.62
Week 38	$\bar{X} \pm s_{\bar{x}}$	0.328± 0.010	0.338± 0.006
	V%	16.89	9.41
Week 70	$\bar{X} \pm s_{\bar{x}}$	0.326± 0.011	0.334± 0.007
	V%	18.07	11.84

5. Eggs structure. The proportion of yolk in the composition of egg yolk increases with age fowl, but decreases the proportion of shell, while egg albumen remains relatively constant. The data we obtained have confirmed this rule, but revealed some differences between the groups, given by the system and growing technology (tab. 6).

Table 6. Structure of studied eggs (%)

Notice			Exp. groups	
			Lc	Lexp
Week 20	Albumen (n=30)	$\bar{X} \pm s_{\bar{x}}$	58.17± 1.784	57.67 ± 1.242
		V%	16.81	11.80
	Yolk (n=30)	$\bar{X} \pm s_{\bar{x}}$	30.20± 0.788	30.39 ± 0.841
		V%	14.30	15.16
	Shell (n=30)	$\bar{X} \pm s_{\bar{x}}$	11.63± 0.288	11.94 ± 0.319
		V%	13.56	14.64
Week 28	Albumen (n=30)	$\bar{X} \pm s_{\bar{x}}$	57.81± 1.437	57.52 ± 1.543
		V%	13.62	14.61
	Yolk (n=30)	$\bar{X} \pm s_{\bar{x}}$	31.20± 0.677	31.37± 0.698
		V%	11.89	12.19
	Shell (n=30)	$\bar{X} \pm s_{\bar{x}}$	10.99± 0.264	11.11± 0.301
		V%	13.16	14.83
Week 38	Albumen (n=30)	$\bar{X} \pm s_{\bar{x}}$	57.52± 1.834	56.58± 1.543
		V%	13.19	14.95
	Yolk (n=30)	$\bar{X} \pm s_{\bar{x}}$	32.17± 0.572	32.44± 0.857
		V%	12.81	14.48
	Shell (n=30)	$\bar{X} \pm s_{\bar{x}}$	10.31± 0.318	10.98± 0.324
		V%	16.89	16.17
Week 70	Albumen (n=30)	$\bar{X} \pm s_{\bar{x}}$	57.38± 1.434	56.55 ± 1.186
		V%	13.70	11.49
	Yolk (n=30)	$\bar{X} \pm s_{\bar{x}}$	32.49± 0.899	32.98± 0.892
		V%	15.16	14.83
	Shell (n=30)	$\bar{X} \pm s_{\bar{x}}$	10.13± 0.341	10.47± 0.364
		V%	18.44	19.06

The eggs from birds exploited in the "free range" system (Lexp), the white share was 56.55 to 57.67%, yolk one of 30.39- 32.98% and the shell of 10.47 to 11, 94%. In the case of eggs obtained from hens bred in intensive (Lc), rates of participation in the structure of the eggs were ranged from 57.38 to 58.17% for white, from 30.2 to 32.49% for yolk and 10.13 to 11, 63% for mineral shell. In all analyzed situations middle character variability was found, both in group Lc (V% = 11.89 to 18.44) and in group Lexp (V% = 11.49 to 19.06).

CONCLUSIONS

Data related to the influence of laying hens exploitation technology on the laid eggs quality could be synthesized as follows:

- eggs with morphologic abnormalities were found in small amounts (0.72-0.81%) during the maximum laying intensity and higher (2.31-2.33%) at the end of production cycle, as consequence of dysfunctions in eggs synthesis;
- eggs weight increased from 48.11-48.89 g (young hens) till 65.22-66.04 g in those found at the end of lay; better results have been achieved within the free-range system;
- shell thickness was found better in hens that had access in the outer paddock (Lexp), being 5.47% higher than in the eggs laid by the hens reared under the deep-litter, environment controlled hall (Lc);
- shell breaking strength was correlated with its thickness, reaching averages of 0.339 kgf/cm^2 in Lexp group and just 0.331 kgf/cm^2 in Lc group;
- in the eggs laid by Lexp hens, which had access to outer paddock, yolk and shell proportions were 0.28% and 0.36% higher than in group Lc.

Conclusions show that the rearing of laying hens (free range) provides not only the condition of the welfare of birds, but also a higher level of trade indicators defining qualities of laid eggs. These elements promote the studied systems, both in terms of producers and consumers.

REFERENCES

[1] Appleby, M.C., 1998-*Modified cage: effects of group size and space allowance on brown laying hens.* Journal Application Poultry Researches, no. 7, 152-161.

[2] Boggia, A., Paolotti, L. And Castellini, C., 2010-*Environmental impact evaluation of conventional, organic and organic-plus poultry production systems using life cycle assessement*. World's Poultry Science Journal, vol. 66, number 1, pg. 95-114. ISBN 978-1-904761-67-9.

[3] Cognome, M., 2010-*Future Policies on the Welfare of Poultry in Europe*. XIIIth European Poultry Conference, Tours-France. World's Poultry Sciences Journal, pg. 59, vol 66, supplement, ISSN: 0043-9339.

[4] Rosenburg, T.B., Tuyttens, F.A., Sonck, B., De Reu, K., Herman, L. and Zoons, J., 2005-*Welfare, health and hygiene of laying hens housed in furnished cages and in alternative housing systems.* Journal Applied Animal Welfare Science, no. 8, pg. 211-226.

[5] Usturoi, M.G., Boişteanu, P.C., Radu-Rusu, R.M., Pop I.M., Doliş, M.G. and Usturoi A., 2009-*Productivity of the laying hybrids reared in different husbandry systems.* Book of Abstracts of the 60th Annual Meeting of the European Association for Animal Production, pg. 328. Wageningen Academic Publishers, The Netherlands. ISBN 979-90-8686-121-7. ISSN 1382-6077.

[6] Usturoi, M.G., R.M. Radu-Rusu, Al. Usturoi, 2010-*Knowledge of the effect exerted by the system used in laying hybrids husbandry on eggs quality.* Lucrări Ştiinţifice, Seria Zootehnie, Vol. 53 (15), pg. 262-267. Editura „Ion Ionescu de la Brad", Iaşi. ISSN Print: 1454-7368; ISSN Electronic: 2067-2330.