KNOWLEDGE OF THE EFFECT EXERTED BY THE SYSTEM USED IN LAYING HYBRIDS HUSBANDRY ON EGGS QUALITY

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Abstract

Eggs classifying on the hens husbandry system criterion generated the false suspicion that those issued from hens accommodated in halls with battery cages would present high "toxic" potential. The experiments focused on the chemical and microbiological features assessment of the eggs produced by hens reared within different systems (L_c=controlled environment hall, in BP-3 batteries; L_1exp=controlled environment hall, in BP-3 batteries with enlarged cages; L_2exp=controlled environment hall, on permanent litter; L_3exp=permanent litter, in a hall opened toward an external paddock). Yolk proteins reached 2.61g/egg in L_c group, respectively 2.62-2.73g/egg in the experimental treatments, while the lipids were found at different levels, meaning 6.27g/egg in L_c and 6.28-6.42g/egg in the other groups. Albumen proteines were assessed at 3.48g/egg in L_c group, respectively at 3.49-3.63g/egg in L_1exp-L_3exp groups. Lowest germs content on the eggshell was found at the eggs produced by the hens reared in batteries, in controlled environment halls (127.01 germs/cm^2 in L_1exp group and 132.65 germs/cm^2 in L_c group), which meant 54.92-76.92% lower, respectively 48.33-69.40% less than the values found at the other husbandry versions. Therefore, the main research conclusion states that husbandry system does not influence the eggs chemical composition but substantially modify the eggshell microbial contamination degree, leading to the risk of an exponential multiplication of germs during eggs storage.

Key words: hens, system, husbandry, eggs, quality

INTRODUCTION

Usually, the classifying of eggs designed for human consumption is done in accordance with their weight group or freshness status. However, during the last period, a new classifying method has been introduced and it is related to the husbandry technology applied in laying hens rearing.

Although this method provides supplemental information to the customers [1], it brought an unfavourable attitude against the super intensive laying hens husbandry, which uses conventional cages. Thus, there is a misconception that conventional technology produces "dead" eggs, which contain high amounts of "stress hormones" and "toxic substances".

Therefore, this paper emphasises on certain results related to the quality of the eggs laid by hens reared in different husbandry systems [4].

MATERIAL AND METHOD

The biological material included 4266 hens - "Lohmann Brown" hybrid, divided in 4 experimental groups, which received different conditions of technology and specific endorsements *(tab. 1)*.

In control group hens (Lc) the principles of the super intensive husbandry system have been used, meaning accommodation in conventional battery cages-B.P.-3 type, providing a density of 4 hens/cage of 2000 cm^2 (500 cm^2 cage floor/hen).

In L_1exp group, the same battery was used (B.P.-3) and the accommodation surface has been enlarged, which meant 1 hen/1000 cm^2, 6 hens/cage of 6000 cm^2.

Table 1. Experimental design

Notice	Experimental group			
	Lc	L_1exp	L_2exp	L_3exp
Husbandry technology	In conventional battery cages	In enlarged battery cages	On permanent litter	On permanent litter, with access to external paddock
Accomodation facilities	Conventional cage -surface=2000 cm^2 -size: L=0.4m; w=0,5m	Modified cages -surface: 2000 cm^2 -size: L=1.2m; w=0.5m	Hall -surface: 252 m^2 -size: L=25.2m; l=10m	Hall -surface: 252 m^2 -size: L=25.2m; w=10m External paddock -surface: 3780 m^2 -size: L=60m; l=63m
Brooding flock	432 hens	432 hens	1512 hens	1890 hens
Brooding density	4 hens/cage of 2000 cm^2	6 hens//cage of 6000 cm^2	6 hens/m^2 hall	- 7.5 hens/m^2 hall - 0.5 hens/m^2 padock
Provided surface/ Hen	500 cm^2	1000 cm^2	0,17m^2	In hall: 0,13 m^2 In paddock: 2,0 m^2

The fowl in the L_2exp group were reared within the intensive system, in a hall whom floor was covered with permanent litter, at a density of 6 hens/m^2. The inner endorsements comprised feeders and water devices, alternatively disposed and double levelled nests, deployed across the walls.

The hens in the L_3exp group have been accommodated within the semi-intensive system, which meant a hall with permanent litter (7.5 hens/m^2 hall) and unrestricted access to an external paddock (0.5 hens/m^2 paddock), though 4 doors. Feeders and water devices have been deployed both in hall and paddock, under a canopy.

Certain traits of chemical and microbiological quality have been assessed for the eggs harvested during the 4 main moments of the laying curve (onset–20th week; peak-28th week; plateau-37th week and laying ceasing-80th week), in accordance to the conventional analysis methods:

- ✓ water content-oven drying, at +105^{0}C;
- ✓ proteins content-Kjeldahl method;
- ✓ lipids content-Soxhlet method;
- ✓ minerals content-calcinations at +550^{0}C.
- ✓ amount of germs on eggshell (N.T.G.)-serial dilutions method.

The experimental data were statistically processed, and the significance of the differences was analysed, using ANOVA method.

RESULTS AND DISCUSSION

1. Yolk chemical composition. Quantitatively, the yolk of a hen egg (60 g) contains: 8.7-10.0 g dry matter; 2.7-3.2 g proteins; 6.0-6.8 g lipids, traces of carbohydrates, vitamins and minerals [2]. The acquired data revealed lower ***dry matter content*** in the yolk during laying onset (fowl aged 20 weeks), being comprised between 9.03±0.380 g (Lc group) and 9.13±0.370 g (L_3exp group), then slightly increased during laying peak (28th week), varying from 9.44±0.302g (Lc group) till 9.50±0.410 g (L_3exp group). Dry matter from yolk continuously increased, although not significant, to reach 9.88±0.486g in Lc, 9.90±0.542 g in L_1exp, 9.96±0.480 g in L_2exp and 9.99±0.500 g in L_3exp when laying ceased (80th week). The differences between groups were not statistically significant. The studied trait had an average variability because the specific coefficient oscillated between 10.10-17.30% *(tab. 2).*

Table 2. Yolk dry matter content

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	9.03±0.380	9.05±0.258	9.08 ± 0.36	9.13 ± 0.37
	V%	14.96	10.14	13.98	14.69
Peak (28^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	9.44±0.302	9.45±0.403	9.48 ± 0.36	9.50 ± 0.41
	V%	10.10	13.47	12.13	13.74
Plateau (37^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	9.54±0.459	9.55±0.345	9.59 ± 0.45	9.62 ± 0.46
	V%	15.12	11.42	14.91	15.21
Ceasing (80^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	9.88±0.486	9.90±0.542	9.96 ± 0.48	9.99 ± 0.50
	V%	15.61	17.30	15.16	15.99

Yolk *proteins content* did not significantly vary between groups, in any of the 4 control moments. In control group, yolk proteins content varied between 2.45±0.034 g (onset) and 2.80±0.053 g (ceasing). At the eggs taken from L_1exp group, the oscillation limits for proteins were of 2.47±0.033 g (onset), respectively of 2.81±0.033 g (ending); in L_2exp eggs, proteins varied from 2.49±0.027 g (onset) till 2.84±0.047 g (ceasing), while in L_3exp group, the same parameter was found between 2.58±0.024 g (onset) and 2.92±0.042 g (laying ceasing). The variability coefficient did not pas over 10% in any situation, which suggest good uniformity for the studied trait *(tab. 3).*

Table 3. Yolk proteins content

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	2.45±0.034	2.47±0.033	2.49±0.027	2.58±0.024
	V%	7.31	7.12	5.89	5.13
Peak (28^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	2.54±0.042	2.56±0.027	2.59±0.025	2.64±0.024
	V%	8.38	5.40	5.02	4.74
Plateau (37^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	2.64±0.041	2.65±0.031	2.68±0.032	2.76±0.032
	V%	7.82	5.88	6.11	5.88
Ceasing (80^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	2.80±0.053	2.81±0.033	2.84±0.047	2.92±0.042
	V%	9.38	5.78	8.14	7.07

Yolk *lipids content* did not show wide oscillations within the experimental groups, the fact being also confirmed by the lack of statistical significant differences *(tab. 4).*

Table 4. Yolk lipids content

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	5.93±0.079	5.95±0.053	5.99±0.068	6.07±0.069
	V%	8.44	5.71	7.33	7.42
Peak (28^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.18±0.077	6.19±0.091	6.24±0.062	6.31±0.063
	V%	7.65	9.06	6.25	6.30
Plateau (37^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.30±0.073	6.31±0.087	6.38±0.091	6.44±0.095
	V%	7.04	8.31	8.79	9.14
Ceasing (80^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.66±0.106	6.68±0.096	6.72±0.093	6.85±0.094
	V%	9.14	8.30	8.11	8.14

Thus, during laying onset (20^{th} week), yolk lipids content reached 5.93±0.079 g in Lc group, 5.95±0.053 g in L_1exp group, 5.99±0.068 g in L_2exp and 6.07±0.069 g in

L_3exp group. Lipids level in yolk increased as fowl turned old. Thus, during last control moment (80th eek), lipids quantities were of 6.66±0.106 g in Lc, 6.68±0.096 g in L_1exp, of 6.72±0.093 g in L_2exp respectively of 6.85±0.094 g in L_3exp. The studied character was homogeneous, knowing that variation coefficient values were found under 10%, in all analysed situations (V%=5.71-9.14).

2. Albumen chemical composition. The albumen of a hen egg weighting 60 g contains 3.8-4.5 g dry matter, 3.3-4.0 g proteins, traces of lipids and minerals [2].

Dry matter content in albumen increased as eggs became heavier. Thus, at the eggs issued from young hens (20 weeks old), albumen dry matter content reached 3.84±0.231 g in Lc group, 3.85±0.173 g in L_1exp group, 3.90±0.220 g in L_2exp group and 3.98±0.210 g in L_3exp group, while the eggs laid when laying approached its ceasing (80th week), had and albumen dry matter content of 4.24±0.166 g in Lc, of 4.26±0.164 g in L_1exp, of 4.32±0.190 g in L_2exp group, respectively of 4.39±0.170 g in L_3exp. The comparison of the results issued from each 4 controls did not reveal differences with statistical significance. Average variability occurred, knowing that variation coefficient oscillated between 12.70-17.82% (*tab. 5*).

Table 5. Albumen dry matter content

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.84±0.231	3.85±0.173	3.90 ± 0.22	3.98 ± 0.21
	V%	16.93	12.70	16.39	15.81
Peak (28th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.93±0.184	3.95±0.181	4.01 ± 0.19	4.08 ± 0.18
	V%	14.12	13.96	15.52	14.52
Plateau (37th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.95±0.203	3.96±0.219	4.02 ± 0.18	4.11 ± 0.17
	V%	16.28	17.54	14.21	13.30
Ceasing (80th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	4.24±0.166	4.26±0.164	4.32 ± 0.19	4.39 ± 0.17
	V%	15.92	15.87	17.82	16.13

Albumen proteins content preserved relatively constant levels across the productive life of the hens. Statistical significance did not occur in any control stage. During laying onset, proteins quantity from albumen oscillated between 3.44 g (Lc, L_1exp) and 3.49±0.008 g (L_3exp). During laying peak, values varied from 3.46±0.013 g (Lc) and 3.60±0.009 g (L_3exp). Proteins were found between 3.49±0.011 g (Lc) and 3.67±0.009 g (L_3exp) during plateau period, while the eggs produced at laying ceasing had proteins contents comprised within the 3.52±0.011 g (Lc) – 3.74±0.0011 g (L_3exp) interval. The studied trait proved to be homogeneous, because variation coefficient did not pass the 10% limit, in any situation (V%=6.13-9.13) *(tab. 6).*

Table 6. Albumen proteins content

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.44±0.012	3.44±0.009	3.45±0.009	3.49±0.008
	V%	8.72	6.89	7.42	6.30
Peak (28th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.46±0.013	3.47±0.009	3.52±0.009	3.60±0.009
	V%	9.13	6.21	6.49	6.60
Plateau (37th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.49±0.011	3.50±0.011	3.59±0.008	3.67±0.009
	V%	7.87	8.21	6.13	6.15
Ceasing (80th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	3.52±0.011	3.53±0.012	3.62±0.012	3.74±0.011
	V%	7.07	8.29	8.18	7.21

3. Shell chemical composition. Mineral substances could be found in eggshell up to 95%, the difference being represented by organic matters (4,4%) and water [2].

During laying onset (20th week), shell minerals were found at various levels: 5.27±0.303 g in control group, 5.28±0.254 g in L_1exp, 5.35±0.200 in L_2exp and 5.58±0.190 g in L_3exp. Statistically significant differences were recorded between L_3exp and Lc, L_1exp groups *(tab. 7).*

Table 7. Minerals content of the shell

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	5.27±0.303[a]	5.28±0.254[a]	5.35±0.20	5.58±0.19[b]
	V%	18.20	15.21	12.41	11.69
Peak (28th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.27±0.321[a]	6.28±0.285[a]	6.31±0.21	6.73±0.19[b]
	V%	16.19	14.39	10.73	10.74
Plateau (37th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.37±0.307[a]	6.38±0.377[a]	6.50±0.30	7.04±0.26[b]
	V%	15.44	18.97	12.39	10.78
Ceasing (80th week)	$\bar{X} \pm s_{\bar{x}}$ (g)	6.55±0.251[a]	6.55±0.338[a]	6.71±0.38	7.85±0.30[b]
	V%	12.11	16.33	14.51	11.35

Statistical significance - ANOVA method: superscripts in the same row
no superscript = not significant differences between means
[ab] = significant differences, $\hat{F} > F_{\alpha}(0.05)$ at 1;18 FD.

Mineral content of the eggshell, during production peak (28th week) reached 6.27±0.321 g in Lc, 6.28±0.285 g in L_1exp, 6.31±0.210 g in L_2exp and 6.73±0.019 g in L_3exp; statistically significance occurring between groups L_3exp and Lc, L_1exp. During laying plateau eggshell minerals were assessed at: 6.37±0.307 g in Lc; 6.38±0.377 g in L_1exp; 6.50±0.030 g in L_2exp and 7.04±0.260 g in L_3exp. The same significance degree was found between L_3exp and Lc, L_1exp groups. During the 80th week of hens life (laying ceasing) highest contents of minerals in shell were recorded, the differences being statistically significant between L_3exp (7.85±0.300 g) and Lc (6.55±0.251 g) and L_1exp (6.55±0.338 g) groups; in L_2exp, shell minerals reached 6.71±0.380 g.

The studied trait presented average to high variability (V%=10.73-18.97).

4. Eggshell microbial load. The spaces designed for fowl husbandry are an appropriate environment for microorganisms development, due to high air temperature and moisture, as well as to the presence of a permanent nutritional substrate (fermented feed, depreciated litter, faeces); certain part of the germs passes on the eggshell, especially when they are not regularly harvested. At the eggs produced during laying onset there were identified 112.78±3.90 germs/cm^2 shell in Lc, 106.31±3.42 germs/cm^2 shell in L_1exp, 152.24±5.43 germs/cm^2 in L_2exp, respectively 169.39±6.12 germs/cm^2 in L_3exp. Statistically, when Lc, L_1exp groups were compared to L_2exp and L_3exp groups, the differences were found highly significant *(tab. 8).*

Very significant statistical significance occurred between Lc and L_2exp, L_3exp groups, respectively between L_1exp and L_2exp, L_3exp groups. They occurred during peak, plateau and mostly when laying ceased. At that latter moment, highest values of microbial load on shell were found: 152.61±4.96 germs/cm^2 in Lc; 146.61±4.98 germs/cm^2 in L_1exp; 245.37±10.48 germs/cm^2 in L_2exp and 289.37±10.48 germs/cm^2 in L_3exp. The studied trait was heterogeneous, the specific coefficient indicating average toward high variability (V%=13.72-19.85).

Table 8. Germs load on the eggshell

Laying moment	Statistical estimators (n=10)	Experimental groups			
		Lc	L_1exp	L_2exp	L_3exp
Onset (20^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	112.78±3.90^a	106.31±3.42^a	152.24±5.43^d	169.39±6.12^d
	V%	18.98	17.62	17.29	19.80
Peak (28^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	125.96±3.72^a	120.14±3.37^a	171.87±5.05^d	198.11±7.72^d
	V%	16.19	15.38	13.72	19.36
Plateau (37^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	139.23±4.66^a	134.98±4.44^a	217.56±7.38^d	241.95±9.04^d
	V%	18.35	18.03	16.55	18.48
Ceasing (80^{th} week)	$\bar{X} \pm s_{\bar{x}}$ (germs/cm^2)	152.61±4.96^a	146.61±4.98^a	245.37±10.48^d	289.37±10.48^d
	V%	17.80	18.62	19.85	19.85

Statistical significance - ANOVA method: superscripts in the same row:
no superscript = not significant differences between means
^{ad} = highly significant differences, $\hat{F} > F_{\alpha}(0.001)$ at 1;18 FD.

CONCLUSIONS

The acquired data proved that fowl accommodation within the conditions provided by the alternative husbandry systems led to an improvement of the eggs chemical composition. However, the change was not significant, compared to the situation of the eggs laid by hens reared in conventional cages, except for the eggshell minerals content. Moreover, the intensive (L_2exp) and especially the semi-intensive husbandry version (L_3exp) induced an worrying increase of germs amount on shell surface, which meant 48.3-76.9% more than the concentration found on the eggs issued from conventional cages version (Lc group).

Consequently, it is recommended to accommodate the laying hens in cage batteries, meaning in conventional ones at the moment (they will be banned from 2010), then in other cages that will be accepted by the welfare regulations (modified, improved, ecologic cages etc) [3].

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