EFFECTS OF THE HOUSING SYSTEM APPLIED IN LAYING HENS REARING, ON THE EXTERNAL QUALITY OF TABLE EGGS

Cristina Gabriela Radu-Rusu[1*], I.M. Pop[1], R.M. Radu-Rusu[1], Aida Albu[1]

[1] *University of Agricultural Sciences and Veterinary Medicine Iasi, Romania*

Abstract

In order to investigate the possibilities to adapt the alternative technological systems approved by the E.U. laws in table eggs production, at small scale farms, a more extended study was carried out. This paper is a comparative synthesis of the results related to external quality of the eggs (weight, shape index, shell traits) produced within three different rearing systems: conventional batteries (group CB-100 eggs), improved cages (group IC-100 eggs) and free range (group FR-100 eggs). Hens were fed a standard layer mixed feed, completed with green mass from a fenced pasture, in the FR system. Investigation methodology comprised modern, standard methods, usually applied worldwide in this research field. Statistics were used to process the acquired data, using ANOVA single factor method. Eggs weight varied between 57.49±0.73g (CB) and 60.99±0.78 g (FR) (no statistic significance), while shape index scored 74.36±0.27% (FR), 77.03±0.39% (CB) and 78.34±0.40% (CI) and significance was noticed. Shell area was calculated within the 64.22±0.52cm^2 – 69.05±0.60cm^2 interval (CB vs. FR groups). Shell gauge presented a reversed dynamics, thus the thickest shells were measured in CB and IC groups (0.38-0.39 mm) and the thinnest ones in FR group (0.33 mm). Of all analyzed eggs, 24% presented shell faults in FR group (mainly marbled shells), 14 % in IC group and 13 % in CB group (2% eggs without shell). These differences, including shell faults issues, suggest an influence of the housing system on eggs external quality. However, other influential factors (age and genotype differences between groups) should be removed before stating a final conclusion on the investigated topic.

Key words: conventional batteries, improved cages, free range, eggshell, quality

INTRODUCTION

Several alternative housing systems for laying hens were proposed by EU legislators to poultry farmers, in order to replace conventional battery rearing and to provide better welfare conditions to fowl producing table eggs [12]. Throughout the last decade, scientists all over the world tried to investigate the effects given by the usage of alternative husbandry systems onto the eggs yield and parameters. The response of hens to enriched and conventional cage systems was investigated. Certain authors stated that egg weight, yield level and some shell quality parameters (specific gravity, shell weight, thickness, and percentage shell) were not significantly affected by the used system [5]. Other researches revealed that high levels of productivity and better egg quality could be obtained in larger furnished cages. [3].

Shell strength was also compared for the eggs laid within different housing systems (battery cages, furnished cages, aviary, and free-range). Thus, classic and furnished cage systems showed the highest percentage of breakage and eggs from the aviary system were stronger than cage eggs (classic and furnished). Moreover, significant correlation was found between eggshell strength and the likelihood of breakage in the production chains, thus after eggs leave production site [4].

It is well known that eggshell quality is influenced by management, nutritional and environmental factors. Among the last ones, high temperatures decrease eggshell quality, mainly due to decreased Ca uptake and respiratory alkalosis [6]. Such environmental stressor has been involved in adverse effects,

*Corresponding author: rprobios@gmail.com
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such as production drop and weaker shell quality, in those layers reared in thermally-stressed environments, affecting finally egg and shell formation, oviposition and oviposition interval [8]. A new question arises. Do within the free range systems, especially during the hot season, the temperature could be adequately managed in order to prevent or reduce heat stress induced by warmer weather. It is a new track of further investigation. Other authors stated that the production system has limited and not significant effects on sensorial, nutritional or functional properties of eggs. Although furnished cages initially resulted in higher percentages of downgraded eggs the progressive improvements in cage design, in equipments and changes in hen group size allow similar performance to conventional cages if hens are break trimmed [10].

There are also opinions stating that the free range systems generate higher occurrence of dirty and shell cracked eggs, induced by significant decrease of certain shell quality parameters, such as eggshell density, thickness and mass, especially toward the end of the laying period [1]. Other finding revealed that deep litter husbandry system provided lower proportion of eggs with shell faults, compared to other investigated housing systems, with horizontal disposing [11].

Within the context stated above, the main goal of the investigations was to comparatively assess the external and internal quality of the eggs produced within three different housing systems for laying hens, which met or still meet the requirements imposed by the EU laws on poultry welfare [12]. This paper reveals the data on the external quality of the eggs issued from conventional or alternative production systems.

MATERIAL AND METHODS

Researches were conducted on field (comparative study between three different rearing systems) in the visited farms and within the facilities and labs of the Animal Science faculty, part of UASVM Iasi.

External quality parameters were assessed on 300 eggs, produced by three populations of hens, which corresponded to certain different housing versions, as follows:

*** CB group (conventional batteries)** – 100 eggs laid by Lohmann Brown Classic hens, aged 27 weeks, reared within UASVM Iaşi BioBase, in a standard BP-3 battery (unimproved), in a isolated-microclimate controlled hall;

*** IC group (improved cages)** - 100 eggs laid by Lohmann Brown Classic hens, aged 26 weeks, reared within a poultry farm using an alternative housing system, respectively improved battery cages "Specht", endorsed with collector and drying belts for feces, into an isolated-microclimate controlled hall;

*** FR group (free range)** - 100 eggs laid by mixed blood laying hens (Rhode Island x Sussex X Plymouth Rock), aged 52 weeks, from a familial farm which applies the free-range alternative system, respectively the accommodation in a hall with deep litter, which also provides access toward a grassy paddock, all the day long.

The methodology used in table eggs quality assessments involves quantitative and qualitative methods of investigation, presented in the scientific literature [2], [9]. There were studied several parameters which depict the external quality of the biological material (table eggs):

* *average eggs weight* (g) was measured on a Denver Instruments Pinnacle 214 analytical scale (range 0.1 mg – 210 g).

* *fissures and other morphological shell faults* were inventoried through ovoscopy, for certain anomalies: broken, fissured, rough, marbled, malformed, soft shell or eggs without shell.

* *eggs width and length (diameters)* were measured with a caliper (precision 0.01 mm).

* *shape index* was calculated through the percent ratio between egg width and length.

* *eggshell area* was calculated using the relation: $A=K*(PI*EL*ew^2/6)^{0.67}$, in which A = area ($cm^2$); K = coefficient with value of 4.63 (corresponding to an egg weight range of 60-70g); PI=π value, EL=egg length (cm), ew=egg width (cm) [7].

* *eggshell thickness* was measured on shell fragments sampled from three different regions of the eggs (round end, sharp end, equatorial circumference), after they were prior washed with distilled water, dried

during 24 hours at +60°C. Measurements were done on a flat, stabile surface, using a digital micrometric device.

The acquired results were subject to database input and statistical processing, using the ANOVA single factor algorithm.

RESULTS AND DISCUSSIONS

Achieved data, related to external quality parameters of table eggs are listed in tab. 1, while the proportion of eggs with morphologic faults from whole biological material is comparatively presented in tab. 2. Thus, egg weight was different, due mainly to fowl age and moment of laying.

Table 1 External quality parameters of the eggs laid by hens reared within conventional (standard cages) and alternative (improved cages and free-range) systems

Analyzed parameters (n=100)	CB group			CI group			FR group		
	$\bar{X}$	$\pm S_{\bar{X}}$	V%	$\bar{X}$	$\pm S_{\bar{X}}$	V%	$\bar{X}$	$\pm S_{\bar{X}}$	V%
Eggs weight (g)	57.49	0.73	12.67	58.40	1.01	9.45	60.99	0.78	12.85
Egg length (mm)	54.67^{a}	0.31	5.61	55.51^{a}	0.39	3.82	57.98^{d}	0.30	5.15
Egg width (mm)	42.03^{a}	0.17	4.15	43.46^{d}	0.24	3.00	43.07^{c}	0.18	4.27
Shape index (%)	77.03^{c}	0.39	5.04	78.34^{d}	0.40	2.81	74.36^{a}	0.27	3.67
Shell area (cm^2)	64.22^{a}	0.52	8.07	67.82^{c}	0.77	6.20	69.05^{c}	0.60	8.64
Shell weight (g)	6.85^{a}	0.09	13.29	7.43^{c}	0.12	8.61	7.07^{a}	0.09	13.03
Shell thickness (mm)	0.38^{d}	0.03	8.28	0.39^{d}	0.01	6.41	0.34^{a}	0.02	7.06

ANOVA: for different superscripts, within the same row: $^{ab,\ bc,\ cd}$-significant differences ($\hat{F}$ >Fα0.05 for 1;198 DF); $^{ac,\ bd}$-distinct significant differences ($\hat{F}$ >Fα0.01 for 1;198 DF); ^{ad}-highly significant differences ($\hat{F}$ >Fα0.001 for 1;198 DF)

Heaviest eggs were found in FR group (60.99±0.78g) laid by hens aged 52 weeks (laying plateau), compared to the lighter eggs produced by the hens aged 26-27 weeks (laying peak) (57.49±0.73 g in CB group and 58.40±1.01 g in IC group). However, no statistic significance occurred between the three compared means.

The dimensional values for eggs length and width (large and small diameters) generated statistic significant differences, including for the shape index, as follows:

- highly significant between FR and IC groups (74.36% vs. 78.34%, $\hat{F} > F\alpha 0.001$ *at 1;198 DF);*
- distinct significant between FR and CB groups (74.36% vs.77.03%, $\hat{F} > F\alpha 0.01$ *at 1;198 DF);*
- significant between CB and IC groups (77.03% vs.78.34%, $\hat{F} > F\alpha 0.05$ *at 1;198 DF).*

For shell area, there were also found distinct significant differences, between the eggs laid by the hens reared in conventional system (CB-64.22±0.52cm^2) and those produced in the alternative husbandry systems (IC-67.82±0.77cm^2 and FR-69.05±0.60cm^2).

These differences could depict alterations in shell calcification, influenced either by nutritional differences between the used systems or feeding technology [6], either by genotype or other environmental factors, such as light and temperature [3], [10]. Other influential factors are the age of fowl, and the moment of the laying curve (eggs volume and weight increases, eggs shape modifies, as production age and laying advances.

Shell gauge was thinner in FR group eggs (0.34 mm), compared to IC and CB eggs (0.39 and 0.38 mm), therefore high significant differences were recorded (these results were also influenced by the laying moment – peak vs. plateau, knowing that any increase in eggs volume leads to decreases in shell thickness, as the quantity of shell fabric deposited per egg remains relatively constant throughout the entire laying period).

Table 2 – Proportion of the eggs presenting morphologic shell faults from whole analyzed eggs

Shell faults (%)	CB group (n=100)	IC group (n=100)	FR group (n=100)
* broken	2	4	5
* micro fissured	1	3	7
* rough	7	5	2
* marbled	1	2	10
* soft shell or without shell	2	-	-
Total eggs with external faults:	13	14	24
Difference, compared to CB group=100%	-	+7.69% +1 p.p.	+84.64% +11 p.p.

Concerning the shell morphologic faults, the lowest proportion was found in CB group (13%), while a close value issued from IC group CI (14%, +7.7% compared to CB), while the highest incidence of faults occurred in FR group (24%, +84.6% vs. CB). It must be noticed that, in conventional cages (CB group), there were produced 2% eggs without shell or presenting soft shells. These faults did not occur in other studied systems, suggesting the installation of a stressful condition in those hens accommodated in standard batteries, due to reduced room and due to higher production intensity. Normally, when hens reared in different production systems have the same age or pass though the same productive period, more shell faults should occur in cage systems, either conventional or furnished [4], [11]. However, the opinions on this topic remain controversial, as could be also seen in other similar studies [1], [3], [10].

CONCLUSIONS

Eggs weight did not significantly differ between the investigated technological systems.

Shell area had higher values in free range eggs, consequently lower thickness, compared to the eggs laid in standard or improved batteries.

Proportion of shell faults was lower in cage production systems, compared to the free range one.

In order to better identify the factors that could induce such differences in external quality, between the various technological systems used in laying hens husbandry, it must be used a biological material closer as genotype, age and production period.

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