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EFFECT OF LAYER AGE AND EGG PRODUCTION LEVEL ON CHANGES IN QUALITY TRAITS OF EGGS FROM HENS OF CONSERVATION BREEDS AND COMMERCIAL HYBRIDS

Józefa Krawczyk

Department of Animal Genetic Resources Conservation, National Research Institute of Animal Production, 32-083 Balice n. Kraków, Poland

Abstract

The aim of the study was to determine changes in interior egg and shell quality traits according to layer age and egg production level in hens of conservation breeds compared to high-yielding commercial hybrids. Subjects were Messa 45 commercial hybrids and 6 conservation breeds/lines represented by 60 layers per group. Compared to 32 weeks, egg weight and yolk weight were found to increase at 56 weeks in all the groups, with more intensive colour and lower total cholesterol content per g of yolk. During the same period, there was a decrease in egg freshness parameters, i.e. albumen height, Haugh units and shell breaking strength. In hens of the native breeds, egg quality traits differed from those found in Messa 45 high-yielding commercial hybrids according to egg production level and layer age, which shows that they are genetically distinct.

Key words: biodiversity, laying hens, egg quality

The quality of eggs laid by hens from conservation flocks is evaluated in terms of their shelf life and biological value. The most important quality traits for consumers are egg freshness, yolk and shell colour, low cholesterol level, high level of unsaturated fatty acids and vitamins, and sensory evaluation. Egg weight and shell breaking strength are important for marketers. Traits important during hatching include shell density, thickness and strength as well as flock health, which has a direct effect on egg quality traits related to embryo growth (Niedziółka et al., 2001). The quality traits of table eggs and methods of their modification have been adequately studied in pedigree and commercial flocks during long-term researches. It is interesting to analyse egg quality traits in non-selected hens of conservation breeds, whose flocks are kept in small populations over many generations. Research has shown that most egg quality traits change mainly as a result of nutrition, although environmental conditions, genotype, age of hens and laying rate are equally important (Solomon, 1991; Scott and Silversides, 2000; Brzóska et al., 2000; Suk and Park, 2001; Rodriguez-Navarro et al., 2002; Van den Brand et al., 2004; Nikolova and Kocevski, 2006).

The aim of the study was to determine changes in interior egg and shell quality traits according to layer age and egg production level in hens of conservation breeds compared to high-yielding commercial hybrids.

Material and methods

Subjects were Messa 45 commercial hybrids and 6 conservation breeds/lines represented by 60 layers per group. The conservation breeds included Yellowleg Partridge (Ż-33), Greenleg Partridge (Z-11), Leghorn (lines G-99 and H-22), Rhode Island Red (R-11) and Sussex (S-66) hens. All layers were kept on litter floor in a windowless building on the farm of the National Research Institute of Animal Production in Chorzelów. They were fed *ad libitum* standard layer diet containing yolk pigments.

Data collected on percent egg production to 56 weeks of age were compared in 4-week periods and egg-laying curves were plotted. Eggs were analysed at 32 and 56 weeks of age by randomly selecting 30 eggs from each group and analysing the eggs using EQM (Egg Quality Measurements) device. The egg quality traits evaluated were shape index, egg and yolk weight, albumen height, Haugh units, shell and yolk colour, yolk cholesterol, shell density, thickness, weight and breaking strength. Shell strength (N) was measured with an Egg Crusher. Yolk cholesterol levels were determined colorimetrically according to the method of Crawford (1958), as modified by Ryś and Bączkowska (1965).

The results were analysed statistically with Duncan's test, using Statgraphics ver. 5.1 software. One-way analysis of variance was used to calculate significant differences for all egg quality traits in each breed/line of hens between the first and second tests performed at 32 and 56 weeks of age, respectively.

Results

During the period under discussion, the egg production of Messa 45 hens (81%) was significantly higher than that of conservation breeds (Figure 1). Mean egg production of the hens of conservation breeds ranged from 56% (Z-11) to 65% (H-22) with egg-laying curves for H-22, R-11 and Ż-33 hens being normal and similar to those of Messa 45 hens. In the other groups, egg production varied considerably between 4-week evaluation periods.

As the data of Tables 1–3 suggest, with the advancing age of the hens interior egg quality traits showed greater changes than shell quality traits. At 56 weeks of age, the shape index increased significantly compared to the first evaluation (32 weeks) in G-99 hens and decreased in R-11 hens, with small changes of this trait in the other groups (Table 1).

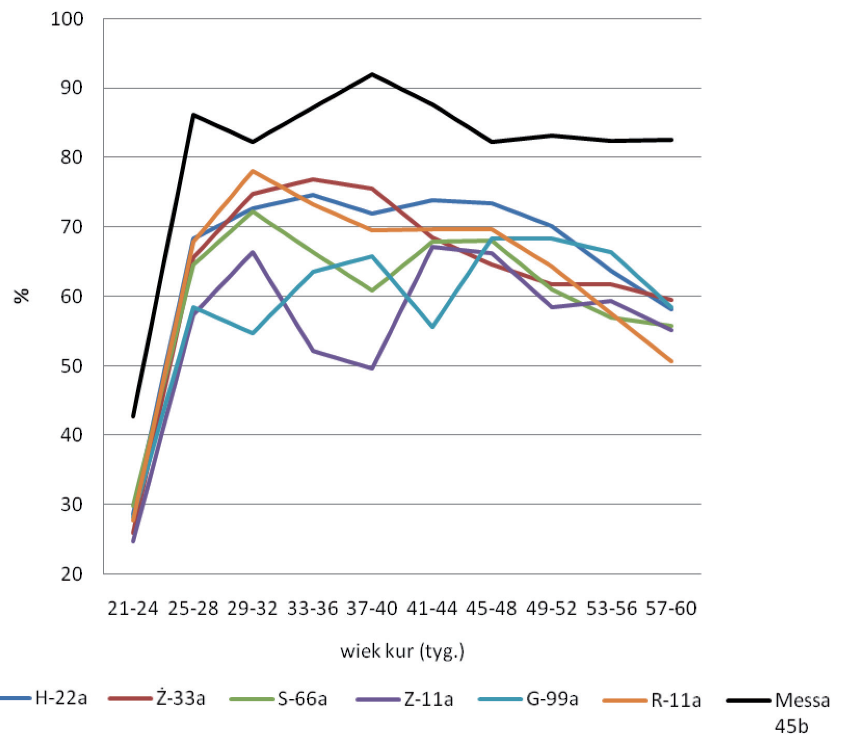

Figure 1. Egg-laying curves from 21 to 60 weeks of hens' age

At the first evaluation time (32 weeks of age), egg weight ranged from 48.8 g (Z-11) to 57.9 g (H-22) in hens of conservation breeds and was 64 g in hens of the commercial line (Table 1). At 56 weeks of age, egg weight in all the groups increased by an average of 14% with significant differences in this respect (P<0.01). Due to the increase of this trait at 56 weeks, proportional to the first evaluation, egg weight among hens of conservation breeds continued to be the lowest in Z-11 hens and the highest in H-22 hens. At 56 weeks, yolk weight was significantly greater in all hen groups (P<0.01), with increases of 27% in conservation breeds and just 20% in Messa 45 hens, in relation to 32 weeks of age (Table 2). The greatest growth dynamics of 35 and 31% was characteristic of the yolks from S-66 and H-22 hens, respectively.

The eggs from young hens (32 weeks) were characterized by good freshness parameters, i.e. albumen height and Haugh units (Table 1). With the advancing age of the hens, this trait decreased significantly in all the groups regardless of hen breed/line (P<0.01 or P<0.05).

At 56 weeks, all the eggs of conservation breed hens had lower total cholesterol content per g of yolk compared to 32 weeks, with significant differences found for S-66, Ż-33 and Z-11 hens (P<0.05). The yolks of Messa 45 hens were characterized by an inverse relationship, because this trait increased significantly from 13.6 to 13.9 mg/g (Table 2). At 56 weeks, yolk colour intensity increased highly significantly (P<0.01) for all hen groups except S-66.

Table 1. Egg shape index, egg weight and egg freshness parameters

Quality traits	Shape index (%)		Egg weight (g)		Albumen height (mm)		JH	
	Age of hens (weeks)							
Line of hens	32	56	32	56	32	56	32	56
S-66	75.3±3.0	75.4±4.4	49.9±2.6**	58.0±3.5**	8.4±1.4**	6.6±1.5**	93.8±6.8**	80.4±10.6**
Ż-33	75.6±2.5	74.4±3.7	50.7±3.5**	56.6±3.7**	8.8±1.5**	6.4±1.5**	95.7±7.6**	78.9±12.8**
Z-11	75.3±2.5	75.6±2.4	48.8±3.2**	56.5±3.8**	7.3±1.2**	5.6±1.3**	87.9±7.0**	74.2±9.5**
G-99	73.8±4.0*	76.3±2.6*	56.9±4.3**	63.9±3.6**	9.0±1.6**	7.1±1.3**	94.6±8.2**	82.5±7.9**
R-11	77.3±2.3*	74.6±2.5*	51.0±2.7**	59.1±3.7**	8.7±1.1*	7.8±1.2*	95.3±5.2**	87.8±6.8**
H-22	75.6±2.8	74.4±3.2	57.9±4.5**	67.5±5.2**	8.5±1.5**	6.6±1.4**	92.0±7.9**	77.8±9.3**
Messa 45	76.6±3.2	76.0±2.9	64.0±4.2**	72.7±4.2**	8.4±1.7*	7.3±1.5*	90.1±9.0**	80.4±10.1**

* Significant differences (P<0.05); ** highly significant differences (P<0.01).

Table 2. Yolk quality traits

Quality traits	Yolk weight (g)		Total cholesterol in yolk (mg/g)		Yolk colour (pts)	
	Age of hens (weeks)					
Line of hens	32	56	32	56	32	56
S-66	13.1±0.7**	17.7±1.1**	14.9±0.4**	14.2±0.1**	7.4±0.9	7.9±1.0
Ż-33	14.2±1.2**	17.8±1.4**	14.6±0.3*	14.2±0.3*	7.4±0.7**	8.7±1.0**
Z-11	14.1±0.9**	17.1±1.2**	14.3±0.5*	13.9±0.3*	6.8±1.2**	7.8±0.9**
G-99	14.5±1.1**	18.0±1.4**	14.4±0.5	14.1±0.1	6.9±0.9**	8.0±0.9**
R-11	14.4±1.4**	18.5±1.4**	14.5±0.4	14.2±0.4	7.6±0.9**	8.8±0.7**
H-22	14.2±1.8**	18.7±1.2**	14.5±0.4	14.1±0.2	7.3±1.1**	8.8±1.3**
Messa 45	15.7±1.1**	18.9±1.0**	13.6±0.2*	13.9±0.3*	6.8±1.1**	10.6±0.8**

* For explanations see Table 1.

Table 3. Egg shell quality traits

Quality traits	Shell colour (%)		Shell thickness (μm)		Shell weight (g)		Shell density (mg/cm^2)		Strength (N)	
	Age of hens (weeks)									
Line of hens	32	56	32	56	32	56	32	56	32	56
S-66	42.3±4.1	39.6±5.8	315±24	324±21	5.1±0.4*	5.5±0.4*	73.9±8.0	72.6±4.8	27.5±9.1	21.2±7.8
Ż-33	53.8±5.8	52.5±5.7	330±33	337±18	5.4±0.5*	5.8±0.5*	77.0±7.5	77.3±5.7	33.1±8.9	27.2±12.6
Z-11	62.1±4.1**	57.7±6.1**	323±28	338±21	5.1±0.3**	5.7±0.4**	76.2±8.8	78.1±5.6	35.0±10.9	30.1±9.6
G-99	69.6±4.5	68.9±1.9	346±34	338±22	5.9±0.9	6.2±0.4	79.8±11.8	78.7±6.1	37.2±10.9	29.3±7.8
R-11	45.4±5.3*	41.5±6.6*	315±18	318±26	5.2±0.5*	5.6±0.4*	73.6±9.3	73.2±5.0	22.9±7.3	28.6±11.1
H-22	70.3±3.3	67.4±2.8	361±19**	338±27**	6.4±0.5	6.4±0.6	84.9±7.7**	76.4±5.0**	30.8±9.7	24.1±9.6
Messa 45	32.5±3.1	33.4±4.3	338±15	342±27	6.3±0.6**	7.0±0.6**	78.7±7.3	80.2±8.7	29.9±7.3	31.9±7.9

* For explanations see Table 1.

Shell colour became darker as hens became older and in the Z-11 and R-11 groups the differences in this respect were significant (P<0.01 or P<0.05) (Table 3). Comparison of shell thickness and density at 32 and 56 weeks of age revealed that these traits decreased significantly in H-22 hens and varied considerably between the other groups. At 56 weeks, all the groups except H-22 and G-99 showed a significant increase in shell weight (P<0.01 or P<0.05). During the same period, egg breaking strength decreased for S-66, Ż-33, Z-11, G-99 and H-22 hens and increased for R-11 and Messa 45 hens. The differences were not significant due to the high coefficient of within-group variance.

Discussion

According to Nikolova and Kocevski (2006), aging hens tend to lay elongated eggs, which was also the case for Messa 45 hens. However, the results obtained for conservation breed hens were diverse and inconsistent.

Many authors point out that egg weight depends on genetic and environmental factors (Romanov, 1995; Islam et al., 2001) and nutrition (Melluzi et al., 2000). Our results and those of other researchers lead us to suggest that regardless of hen breed, egg weight and the correlated yolk weight increase with the age of layers (Trajcev et al., 2002; Van den Brand et al., 2004; Czaja and Gornowicz, 2006). As is evident from the observations of Sokołowicz and Połtowicz (2002), egg weight in commercial flocks is also determined by egg production rate – the greater it is, the smaller the egg weight. As required by the conservation programme, conservation flocks are not selected to improve productive traits. As a result, their egg production is significantly lower compared to commercial flocks, which is clear from Figure 1. An inverse relationship was observed at this point in that Z-11 hens with the lowest egg production level laid the smallest eggs. Significantly greater egg weights were obtained by Messa 45 layers, which stand out with respect to this trait among other commercial flocks (Czaja and Gornowicz, 2006).

The higher the albumen and Haugh units, the fresher the egg, and egg freshness is determined mostly by storage conditions (Bell et al., 2001). A study by Solomon (1991) confirmed the known fact that egg quality deteriorates with the age of hens. In our study, regardless of hen's genotype, eggs from young hens were characterized by significantly higher Haugh units and albumen height, which is indicative of their better quality and agrees with the findings of Van den Brand et al. (2004) and Czaja and Gornowicz (2006) who, similar to our study, found differences between hen varieties.

Yolk colour intensity, which is affected mainly by nutrition, is an important factor for the consumer. Our study showed that eggs laid by older hens were characterized by better (more intensive) colour, which is consistent with the findings of Kuchta et al. (1999) and Czaja and Gornowicz (2006).

Research with highly productive commercial hybrids has shown that unlike other components, the cholesterol content of egg is stable and changes little under the influence of environment and feeding (Sparks, 2006). Hall and McKay (1992) found considerable differences in the level of cholesterol per g of yolk between hen breeds and showed that cholesterol level tends to decrease with the age of hens, as confirmed by our study with conservation breed hens. Washburn and Marks (1977) reported that there is an inverse relationship between yolk cholesterol level and egg production level in the flock, which concurs with our results for Messa 45 commercial hens.

Shell colour intensity depends on hen's genotype, age and egg production rate (Scholtysek, 1988). The concentration of the brown pigment decreases as egg production period progresses and this situation occurred in our study for highly productive Messa 45 hens. In the case of layers from conservation flocks, significant differences were found between hen breeds and lines for this trait, which was correlated the most with hens' genotype. The effect of age and egg production rate on this trait varied considerably, confirming the biodiversity and unique characteristics of these birds compared to the commercial hybrids.

Our results obtained for egg shells from conservation breeds hens S-66, Ż-33, Z-11 and H-22 agree with Brzóska et al. (2000), who observed that after the peak egg-laying curve is over, the decreasing number of eggs laid by hens is paralleled by the increasing individual weight of eggs and deteriorating shell quality. An opposite relationship occurred for the G-99 line, in which shell strength decreased despite the fact that egg production rate did not decline, and for the R-11 line, in which the decrease in egg production rate was paralleled by increased shell strength. In R-11 and Messa 45 layers, shell strength was slightly better in older compared to younger hens, with no significant differences. Roland and Bryant (2000) reported that changes in the mechanical properties of the shell that take place with age are often associated with slower mineralization, which increases the incidence of internal shell cracks. The same authors also showed that the shell becomes thinner with increasing egg weight. In our study, we found no clear relationship between the qualitative and mechanical parameters of the shell.

The present study suggests that compared to high-yielding commercial hybrids, native breed hens kept for many years in closed populations that were not selected for improved performance, have remained genetically distinct, as evidenced by some egg quality traits that change according to egg production level and layer age.

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JÓZEFA KRAWCZYK

Wpływ wieku niosek i poziomu nieśności na zmiany w cechach jakości jaj kur ras zachowawczych i mieszańców komercyjnych

STRESZCZENIE

Celem badań była analiza kształtowania się cech jakości treści jaj i skorup w zależności od wieku kur oraz poziomu nieśności u niosek ras zachowawczych w porównaniu do wysoko wydajnych mieszańców towarowych.

Materiał doświadczalny stanowiły mieszańce towarowe Messa 45 oraz 6 ras/rodów zachowawczych, w liczbie po 60 niosek w grupie.

Nieśność kur Messa 45 była wysoka (średnio 81%), podczas gdy wśród ras zachowawczych jej poziom był znacznie niższy (56–65%). We wszystkich jajach kur ras zachowawczych w 56. tygodniu życia zanotowano obniżenie zawartości cholesterolu całkowitego w 1 g żółtka w porównaniu do badania w 32. tygodniu życia, natomiast w żółtkach jaj kur Messa 45 zanotowano odwrotną zależność. W 56. tygodniu we wszystkich grupach wzrosła masa jaj i masa żółtek, których barwa uległa także znacznej poprawie, natomiast obniżyły się parametry świeżości jaj, tj. wysokości białka i JH. Wraz z wiekiem kur obniżyła się wytrzymałość skorup jaj na zgniecenie. U kur rodzimych ras stwierdzono inne kształtowanie się niektórych cech jakości jaj w zależności od poziomu nieśności i wieku niosek niż u wysoko wydajnych mieszańców towarowych Messa 45, co potwierdza ich odrębność genetyczną.