

## COMPARATIVE STUDY ON MORPHOLOGICAL QUALITIES OF EGGS FROM NEW AUTOSEXING LAYER HYBRIDS FOR FREE RANGE POULTRY FARMING SYSTEM

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### Abstract

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The aim of this study was to evaluate five genotypes autosexing layer hybrids by feathering colour, obtained from the rich gene pool of layer hens, adapted to raising in free range poultry farming system. One of the related tasks was to establish the influence of the genotype on morphological quality of eggs in the five hybrid groups as an element of evaluating their egg production performance. Experiments were performed at the Agricultural Institute – Stara Zagora in 2015. Eggs were collected from five genotypes autosexing hybrid hen strains (by feathering colour). Hybrids crosses were obtained from the following lines of the national gene pool- line Ss (Sussex- Columbian feathering), line NHG (German New Hampshire – red feathering), line P (Rhode Island Red, red feathering), line E (Barred Plymouth Rock), line I (Barnevelder). For the purpose of investigation morphological traits of eggs, 30 eggs were obtained from 34-week- old layers from each of the five groups. The eggs produced by hybrids from group V were the heaviest – 62.47 g with Barred Plymouth Rock as maternal form, whereas eggs of group IV (line Ss: Sussex as maternal form) were the lightest – 53.50 g at  $p < 0.001$ . The eggs of the other hybrid groups were at the intermediate level. The weight of the shell with shell membranes had a highest significant value in heaviest eggs- those of hybrids groups I, V, II (6.14 g, 6.13 g and 6.01 g respectively). The egg weight correlated to the shell percentage. The differences were significant at various levels of significance ( $p < 0.05$ ). The absolute yolk weight did not tend to increase in eggs with higher weight. The trait varied at a various extent among the hybrids groups. The yolk index was not associated to egg weight and yolk weight. The groups with highest egg weight to yolk weight ratio were not the heaviest ones. The eggs of studied hybrids with the highest egg weight had more albumen. In group II, its amount was 36.54 g, group V – 35.83 g, group I – 35.12 g with highly statistically significant differences between groups III and IV.

*Key words:* eggs; egg weight; shape index; egg shell; layer hybrids hens; morphological egg quality; Haugt unit; indices

### Introduction

The creation of new hybrid combinations in poultry husbandry is a process which aims at the maximum utilisation of the genetic potential of the egg- and broiler- designated breeds. The process of creating new lines and combinations in poultry farming is ongoing. Every company that wishes to resist the market's competition has to consider the constant changes in the customers' demands.

With regard to eggshell colour, two types of egg-laying hybrids are used in commercial poultry industry on the basis of two breeds- White Leghorn with white eggs and Rhode Island with brown-shelled eggs. Apart the industrial-scale production, raising backyard chickens is also practiced. Two types of breeding and hybrid material clients are formed, and during the last decade, the intensive development of organic production systems resulted in appearance of small farms which require a medium- size hen with good egg production

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performance, adapted to outdoor rearing. The group of „other chicken hybrids for eggs“ Kabakchiev et al. (2014) comprise those originating from medium-sized breeds- Sussex, New Hampshire, Plymouth Rock (barred and white), Rhode Island- suitable for production of autosexing hybrids. The existing practice both at a national and international scale has shown that these breeds and their crosses are most appropriate for free-range farms. Phenotypically, the hybrids could be divided into brown, black, silvery, barred, red-brown. In organic farms, their egg laying capacity is 250-280 eggs, Also, they produce brown shelled eggs, which are demanded on retail markets. The heterogamy of female domestic fowl is used in poultry breeding practice for production of autosexing hybrids.

The use of locus S considerably eases the performance and effectiveness of manufacturing at sexing of one day old chickens. One person for eight hours can process 30 000 chickens in error of 0.1% (Belorechkov, 1990). In literature, the genetic determination of sexual ratio 1:1 is explained by the presence of homogamete male (ZZ) and heterogamete female (ZW) (Florin, 2011).

The selection work for creation of autosexing hybrids consists of genetic and selection stages (Silin, 1988; Bichaev, 2001; Varakina et al., 2008). The first stage is the choice of original breeder forms, crossing, genetic and phenotypic analysis of the progeny and checkup for auto-sexing. The creation of new hybrid combinations for eggs is aimed at improvement of main selection traits, among which are egg morphological traits. The latter include traits which are important not only for breeder but also for stock eggs. A special attention during the creation of chicken hybrids is paid on the quality of the different egg parts: shell, albumen, yolk. Numerous authors (Kabakchiev and Todorova, 1986; Lalev, et al., 2010; Gerzilov, 2011; Lukanov et al., 2014) have studied the effect of chicken and hybrid genotypes on egg quality and on their potential in free- range production systems (Rizzi et al., 2002, 2005, 2007).

The main purpose of this study was to evaluate five genotypes auto-sexing hybrids by feathering colour, obtained from the rich gene pool of layer hens, adapted to raising in organic poultry farms. One of the related tasks was to establish the influence of the genotype on morphological quality of eggs in the five hybrid groups as an element of evaluating their egg production performance.

## Materials and Methods

The experiments were performed in 2015 in the stud farm of the Hybrid Centre of Poultry Breeding at the Agricultural Institute – Stara Zagora. The studied eggs were collected from five genotypes autosexing hybrids hens strains

(by down colour) with the following phenotype:

I. group (♂ line P X ♀ line E) – day-old males are black with a white spot on the head and light belly; females are black.

II. group (♂ line NHG X ♀ line E) – males are black with a white spot on the head; females are black.

III. group (♂ line P X ♀ line Ss) - males with yellow down; females: with red-brown down

IV. group (♂ line NHG X ♀ line Ss) - males with yellow down; females: with red down

V. group (♂ line I X ♀ line E) – males are black with a white spot on the head; females are black

The five group- hybrids crosses were obtained from the following lines of the national gene pool- line Ss (Sussex-Columbian feathering), line NHG (German New Hampshire- red feathering), line P (Rhode Island Red, red feathering), line E (Barred Plymouth Rock), line I (Barnevelder).

Subject of study are the five hybrids group were reared under equal technological conditions- density, equal feeding and drinking width, deep permanent litter. They were fed ad libitum with standart feed ration prepared in the fodder factory of the Agricultural Institute according to requirements of age and category of birds throughout the whole experimental period with crude protein 16.14%; lysine 0.75, methionine 0.345, Met.+ cysteine 0.607% metabolizable energy 2744.385MJ/kg; calcium 3.235%; available phosphorus 0.733%.

For investigation of morphological traits of eggs, 30 eggs – a random sample of one week production, were obtained from 34-week-old hybrids layers (the middle on productive usage, at 21 to 47 week) from each of the five hybrids groups. The following traits were determined:

- weight: measured with a balance with precision up to 0.01 g.

- shape index – SI (%) – through measurement of big and small egg diameters with Vernier caliper and calculation using the formula:  $SI (\%) = (d/D) * 100$  (Romanoff and Romanoff, 1949) where SI is the shape index, d – small diameter of the egg, mm, D – big diameter of the egg, mm.

- Yolk index YI (%) – through measurement of yolk diameter /d/ with a Vernier caliper and its height /h/ with an micrometer (mm) according to the equation:  $YI (\%) = (h/D) * 100$ , (Romanoff and Romanoff, 1949) where YI: yolk index, h – yolk height, mm; D – yolk diameter, mm.

- Albumen index AI % – through measurement of big and small thick albumen diameters /D and d/ with Vernier caliper and albumen height /h/ with a micrometer. It was determined using the formula:  $AI (\%) = [h/(d+D)/2] * 100$  (Romanoff and Romanoff, 1949) where AI – albumen index, h – thick albumen height, mm, d – small diameter of the thick albumen, mm, D – big diameter of the thick albumen, mm

● Haugh units – by the formula  $HU = 100 \log (H + 7.57 - 1.7 W^{0.37})$  (Haugh, 1937) where HU – Haugh units, h – thick albumen height, mm, and w – egg weight, g

● Yolk colour score: evaluated visually using the 15-point La Roche scale.

● eggshell thickness together with shell membranes ( $\mu\text{m}$ ) – measured with micrometer Ames 25EE, in three zones (both ends and equator), retaining the average of three measurements

● Albumen, yolk and egg shell weights – with a balance, precision of 0.01 g

● The relative content (in%) of the shell, the yolk and albumen by weight of the egg

The data of morphological traits of eggs and ratios of their components were submitted to statistical analysis via the ANOVA MS Excel 2010 and t-Test: Two-Sample Assuming Equal Variances and presented in Tables 1 and 2.

## Results and Discussion

The genotype affects mainly egg weight and egg shell characteristics. The correlations between the egg weight and the albumen weight, yolk weight, egg shell weight are high and range from 0.67 to 0.97 (Zhang et al., 2005). The egg weight had a significant effect on the others traits characterized the morphological egg quality.

**Table 1**  
**Morphological traits of eggs at age of 34 weeks**

Parameters	I group	II group	III group	IV group	V group
	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$
Egg weight ,g	60.07±1.04 1:4***	60.84±0.85 2:4***	57.32±0.62 3:4***	53.50±0.87	62.47±0.68 5:3***5:4***
Shell weight, g	6.14±0.11 1:3*** 1:4***	6.01±0.14 2:3*** 2:4***	5.60±0.10 3:4***	4.94±0.09	6.13±0.10 5:3*** 5:4***
Yolk weight	17.61±0.28	18.53±0.25 2:1* 2:3*	17.58±0.31 3:4* 3:5***	18.45±0.28 4:1**	20.18±0.29 5:2*** 5:4*** 5:3***
Albumen weight,	35.12±0.94 1:4***	36.54±0.76 2:3*** 2:4***	33.23±0.43 3:4**	31.05±0.7	35.83±0.54 5:3*** 5:4***
Shape index, %	76.60±0.41	78.06±0.50	80.1±0.62 3:1* 3:4* 3:5*	77.74±0.49	76.96±0.58
Yolk index, %	42.58±0.49 1:2*** 1:4***	39.69±0.68	43.44±0.5 3:2*** 3:4***	39.65±1.7	43.06±0.49 5:2*** 5:4***
Haugh unit	81±0.94 1:4*** 1:2*** 1:5*	76±1.1 2:3*	80.27±1.7 3:4* 3:2*	76.21±1.1	77.25±1.1
Shell thickness,mm	0.35±0.004 1:4* 1:5*	0.34±0.007	0.34±0.007	0.33±0.007	0.33±0.007
Albumen index, %	7.98±0.26	7.21±0.36	8.61±0.39 3:2** 3:4**	7.16±0.34	7.80±0.34
Yolk color of the egg	5.3±0.13	6.76±0.28 1:2***	6.33±0.18 1:3*** “	8.04±0.2 4:3***4:2***4:1***	8.04±0.2 1:5***

at \*\*\*p < 0.001, \*\*p < 0.01, \*p < 0.05

**Table 2**  
**Percentage of shell, yolk and the whites of the egg mass, %**

Parameters	I group	II group	III group	IV group	V group
	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$	$\bar{x} \pm S_x$
Shell as a per cent of egg weigh	10.26±0.11 1:5**;1:3**;1:4***	10.24±0.11	9.75±0.16 3:4**	9.25±0.11	9.81±0.12 5:4**
Yolk as a per cent of egg weight	29.47±0.57	30.61±0.49	30.64±0.35	33.36±0.56 4:5*** 4:2*** 4:3*** 4:1***	32.35±0.46
Albumen as a per cent of egg	58.52±0.67	59.92±0.53 2:3** 2:4* 2:5***	57.97±0.39	58.16±0.53	57.37±0.39

at \*\*\*p<0.001, \*\*p<0.01, \*p<0.05

The established values of the trait in this study (Table 1) were the highest in hybrid combinations with line E (Barred Plymouth Rock) was the maternal form, namely group V – 62.47 g, whereas eggs of group IV were the lightest – 53.50 g with line Ss (Sussex) as maternal form ( $p < 0.001$ ). The eggs of other groups occupy an intermediate position. There was a statistically significant difference between the weight of eggs from hybrid group II(line NHG X line E) (60.87 g), hybrid group III(line P X line Ss) with 57.32 g and group IV(line NHG X line Ss) ( $p < 0.001$ ). The investigations of other researchers as Singh et al. (2009) proved that egg weight was inflicted by both genetic and environmental factors. The egg weight 55.38 g ( $p < 0.001$ ) of Nera were significantly higher than tree others genotype (Khan, 2004) and depends on genetic and environmental factors. The different bird species have widely varying eggs mass. Pustovaja (2013) found that different breeds are also big differences in egg mass. The layer of the same breed can have significant differences in the egg mass. It increased continuously with age (Akimova, 2002). There is a certain relationship between the number of produced eggs and their weight (Pahomova, 2009). In more intense egg production, increased number of eggs results in slight reduction of their weight. The differences among other groups were insignificant. Some research teams as Baidevliatova et al. (2013) have studied the weight of eggs produced by hens at a different age. They found out that at 38-46 weeks of age, hens produced heavier eggs compared to 30-35-week-old hens. This increase in the weight of eggs resulted from higher absolute weights of its parts.

The quality of eggs and their weight are closely associated to the amount and quality of egg yolk and albumen. As the weight of egg increases, the relative proportion of the yolk becomes higher on the account of that of albumen, altering their ratio. Similar results are reported by Rizzi et al. (2005), who investigated the eggs of four lines of hens and found out various amount of yolk. Gerzilov (2011) communicated for highest average weight of the eggs and the yolk of the laying period in laying breed White Plymouth Rock grown in bio conformed conditions. The absolute yolk weight tended to be higher in heavier eggs in line with the results of Lalev et al. (2010) for preserving high egg and yolk weight (Table 1). For instance, yolk weight was the highest in hybrid group V(line NHG X line Ss) – 20.18 g ( $p < 0.001$ ), and the lowest in hybrid groups III(line P X line Ss) and group I(line P X line E) – 17.58 g and 17.61 g respectively. The trait varied at a various extent among the other groups. The most commonly used indices of albumen and yolk quality are the respective indices. As seen from Table 1, the yolk index was the highest in group III(line P X line Ss) – 43.44, superior to values in hybrid groups II(line NHG X line E) and IV(line NHG X

line Ss) which had the lowest ratio between yolk height and diameter (39.69 and 39.65 at  $p < 0.001$ ). The values except group III(line P X line Ss) are lower than yolk index on egg from ISA Braun – 44.38; Hisex Braun – 43.93 and Moravia BSL- 46.56, results described by Zita L., (2009). These values of the trait were lower than data reported by Mincheva et al. (2011) and were comparable to those communicated by Lukanov (2014). Lower values of the YI were explained by Gerzilov (2011) with the lower egg weight. As could be seen from the study, the yolk index did not depend on egg weight and yolk weight, which agrees with the data reported from Sharlanov (1973) and Hristakieva (2005).

The relative proportion of the yolk (Table 2) from the egg was the highest in hybrid group IV(line NHG X line Ss): 33.36% vs 32.35% in group V ( $p < 0.001$ ). The groups with highest egg weight to egg albumen weight were not the groups with the highest average egg weight. This trait is important insofar as it is inherited.

The heaviest eggs of studied hybrids contained more albumen (Table 1). In group II, its amount was 36.54 g, group V(line I X line E) – 35.83 g, group I(line P X line E) – 35.12 g with highly statistically significant differences between groups III and IV. Our results coincided to those of (Khan, 2004).

The egg qualities are closely related to the quantity and quality of the white and yolk. The most widely used indicators for determining the quality of the white and the yolk are their indexes. For optimum we can accept the following values: Index of protein 6-7 and index the yolk 40- 45.

The albumen index did vary within a wide range in studied groups. The hybrids groups with similar values did not exhibit statistically significant differences. Egg albumen quality, evaluated through the albumen index showed statistically significant differences ( $p < 0.01$ ) between groups III(line P X line Ss) and II(line NHG X line E) – 8.61-7.21 respectively and groups III(line P X line Ss) and IV(line NHG X line Ss) – 8.61-7.16. There was no correlation between AI and egg weight.

The relative proportion of albumen vs the whole egg (Table 2) assumed various but insignificantly different values except for values in group II(line NHG X line E) 59.92% vs groups III(line P X line Ss), IV(line NHG X line Ss) and V(line I X line E) 57.97%, 58.16% and 57.37% respectively among which the differences were substantial ( $p < 0.05$ ). In other experiments (Lewko et al. 2009) the laying hens M-55 demonstrated highest content of albumen 60.87%, albumen height 9.01 mm, Haugh units – 92.01, but not with the highest albumen weight – 40.19 g.

The importance of studied traits for the selection of egg-laying chickens has been studied by a number of research-

ers. Hartmann et al. (2003) reported the following heritability coefficients – 0.33 for yolk proportion; 0.4 – for yolk weight; 0.57 – for albumen weight. In their study Suk, and Park (2001) and Ozcelik (2002) observed positive correlation between albumen, yolk and shell weights and negative relationship between egg weight and albumen/yolk ration, whereas Hussein et al. (1993)- a low positive correlation between the last two indices.

Egg shell quality and egg internal quality are of major importance to the egg industry worldwide. Egg shell quality may be affected by the strain and age of hen; induced moult; nutritional factors; general stress and heat stress; disease, production system, or addition of proprietary products to the diets. An understanding of the range of factors that affect egg shell quality and egg internal quality is essential for the production of eggs of high quality (Roberts, 2004). The results about the eggshell and shell membranes weight in the studied hybrids groups (Table 1) was the highest in heaviest eggs obtained from groups I(line P X line E), V(line I X line E), II(line NHG X line E) – 6.14 g, 6.13 g and 6.01 g or by 0.54 g higher than the lowest eggshell weight of group III(line P X line Ss) (5.60 g) and by 1.2 g higher than group IV(line NHG X line Ss) – (4.94 g). Differences are mathematically justified at  $p < 0.001$ . This fact is attributed to the correlation between egg weight and shell weight (Suk and Park, 2001; Oblakova, 2006; Lalev et al., 2010).

Eggshell thickness is one of the most important traits of eggs. The thickness of the shell together with membranes was within the allowances (Table 1), an indirect index of its strength. It was from 0.35 mm for eggs of group I to 0.33 mm in eggs of groups IV(line NHG X line Ss)- and V(line I X line E). The differences were statistically significant at  $p < 0.05$ . In this study, the eggshell thickness was not proportional to egg weight. The result agreed with the results 0.34- 0.38 mm of other author (Khan, 2004), who also reported that was a significant effect of type of birds on the egg shell thickness. With regard to shell thickness of the different chicken lines and breeds, Ketelaere et al. (2002) demonstrated considerable differences, while Padhi et al. (1998) did not report such variations. But the contrary Streltsov (2013) establishes that an increase in the mass of the egg lead a reduction the thickness of the shell. Mincheva et al. (2010) established that eggs of line SZ80 M and line G were with the thickest shells- 0.39 mm and 0.38 mm respectively. The shell thickness is positively correlated to egg weight.

The amount and thickness of the egg shell have been found to be related to egg shell strength. Shell weight may be measured by breaking open an egg, carefully rinsing the pieces of shell, drying them and then measuring shell weight. The shell weight can then be calculated as a proportion of

egg weight to give percentage shell. The percentage of the eggshell (Table 2) varied among studied hybrids. The difference between the highest value – 10.26% in group I and the lowest (9.25% in group IV line NHG X line Ss) was 5.94 points. The hybrids from I group were significantly ( $p < 0.01$ ) different from each other genotypes with values – III – 9.75%; V – 9.81%; IV – 9.25%. In this study, egg weight was associated to shell percentage, contrary to what was reported by Tharrington et al. (1999) but its relationship with shell thickness and egg weight was inconsistent.

The different genotype laying hens have (Curtis et al., 1985) as a result of selection different egg shell quality, egg size and production. The shape of eggs is a genetically determined trait with heritability coefficient between 0.1 and 0.6 (Stevens, 1991). Most commonly, the ratio between the small and big diameter is accepted as a parameter of egg shape. Chopracarn et al. (1998) observed that the shape of eggs did not depend on their weight. However, the breed had a significant impact on egg shape (Kabakchiev and Todorova, 1986). Dottavio et al. (2001) no find differences in the egg shape between hybrids and baselines hens. Table 1 shows that the highest ratio between both egg diameters vary between of five genotypes at 76.60 to 80.10. Exhibited by hybrids hens from group III (line P X line Ss) with 80.1 are superior at  $p < 0.05$ . The shape index in studied lines did not vary significantly among the groups, unlike the data of Baidevliatova et al. (2013) evidencing a very broad range of variation of egg shape index: 57-91%. Oblakova (2006) reported that the shape of eggs did not depend on their weight, while the genotype had a significant impact on this trait.

Haugh unit is the measure of albumin quality which determines the quality of the egg. From all egg quality parameters, the Haugh units exhibited the strongest correlation to albumen index (Baidevliatova et al., 2013). It varied widely limits 60-90 and depends from many factors – age, technologies, nutrition etc. (Van Den Brand, 2004).

In this study Haugh unit varied within a broad range among the hybrids groups: from 81 in group I(line P X line E) to 76 in group II(line NHG X line E) – ( $p < 0.001$ ). The values of the trait differed substantially ( $p < 0.05$ ) between group III (line P X line Ss) with 80.27 and both groups IV and II. In this case the heavier eggs and those with heaviest albumen weight have not the highest Haugh unit values. A high variation of the trait within breeder groups was detected by Lalev et al. (2010). Haugh units are influenced by genetic potential of birds. For eggs of chickens, optimum Hough unit values are 65-87. Lewko et al. (2009) communicate in their research that polish breeding laying hens have Haugh unit- at 80.04 next to 92.01. Parmar et al. (2006) observed wide range of Haugh unit value

for Kadaknath birds starting from 62.58-90.00 from India. Chatterjee et al. (2006) also reported lower Haugh unit values, 59.62-71.62 for the White Leghorn strains. The higher Haugh unit score in the Naked neck chicken indicated the superior quality of the albumin. Haugh unit values ranging from 100.25-106.29 were reported in crosses of naked neck, frizzle and normal chicken from Nigeria which are higher than the present values (Nwachukwu et al., 2006). Another author Tharrington et al. (1999) conducted their study on four lines of layers wherein the egg albumen of CCS birds demonstrated highest Haugh unit 72.66. It should be stated that albumen index and Haugh units decrease as the age of birds advances. Haugh unit of brown-shelled eggs were lower (Flock, 2001) because chickens laying white eggs were selected for a longer time which has influenced the egg albumen quality.

Evaluation of external and internal quality of the egg is essential as consumers prefer better quality eggs. From the groups placed under similar conditions of rearing and feeding, the eggs yolk of different genotypes- groups IV and V were most intensively coloured – 8.04 and according to La Roche scale. The yolk eggs of the other groups were of lighter colour ( $p \leq 0.001$ ). On group II (line NHG X line E) and group III (line P X line Ss) are registered eggs yolk color 6.76 and 6.33 who are superior ( $p \leq 0.001$ ) group I (line P X ♀ line E) – with 5.3. Studying White Lohmann LSL and Brown ATA-K-S laying hens, Küçükyılma K. et al. (2012) communicated that genotype significantly affected all egg shell quality and internal egg quality characteristics ( $p < 0.01$ ). On the other hand, the egg shape index, shell thickness, and yolk color were influenced by the conditions of the rearing system ( $p < 0.05$ ). Also, a significant rearing system by genotype interaction was observed for overall internal egg quality traits, excluding albumen height, Haugh unit, and yolk color ( $p < 0.05$ ). Islam et al. (2001) reported that the yolk colour reduced gradually up to 40 weeks of age lower estimates (4.5) in Naked neck chicken.

## Conclusions

The eggs produced by hybrids from group V were the heaviest – 62.47 g with Barred Plymouth Rock as maternal form, whereas eggs of group IV (line Ss: Sussex as maternal form) were the lightest – 53.50 g at  $p < 0.001$ . The eggs of the other hybrids groups occupied an intermediate position.

The weight of the shell with shell membranes was statistically significantly the highest in heaviest eggs- those of hybrids groups I (line P X line E), V (line I X line E),

II (line NHG X line E) – 6.14 g, 6.13 g and 6.01 g respectively. The egg weight correlated to the shell percentage. The differences were significant at various levels of significance ( $p < 0.05$ ).

The absolute yolk weight did not tend to increase in eggs with higher weight. The trait varied at a various extent among the hybrids groups. The yolk index was not associated to egg weight and yolk weight. The groups with highest yolk weight to egg weight ratio were not the heaviest ones.

The eggs of studied hybrids with the highest egg weight had more albumen. In group II (line NHG X line E), its amount was 36.54 g, group V (line I X line E) – 35.83 g, group I (line P X line E) – 35.12 g with highly statistically significant differences between groups III (line P X line Ss) and IV (line NHG X line Ss).

From the groups placed under similar conditions of rearing and feeding, the eggs yolk of different genotypes- groups IV and V were most intensively coloured – 8.04. The yolk eggs of the other groups were of lighter colour ( $p \leq 0.001$ ).

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