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Original Contribution

PRODUCTIVE PERFORMANCE OF EASTER EGGER CROSSES OF ARAUCANA AND SCHIJNDELAAR ROOSTERS WITH WHITE LEGHORN HENS

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ABSTRACT
During the past decade, consumers in some regions of the world evidenced a marked interest to eggs with non-traditional shell colour. The aim of the present study was to investigate the productive traits of Easter eggers, obtained by crossbreeding of Araucana and Schijndelaar roosters with White Leghorn layer hens. For this purpose, a total of five groups of hens were used: three control: group L (White Leghorn), group A (Araucana), group S (Schijndelaar) and two experimental: group AWL (F1 Araucana×White Leghorn) and group SWL (F1 Schijndelaar×White Leghorn). During the production cycle which continued up to 65 weeks of age, the following traits were evaluated: live weight at 20% and 50% egg production; economic maturity; average weekly feed intake and feed conversion, egg production and egg weight.
At the age of 50% egg production, Araucana had the highest live body weight (1408.25 ±19.25 g), and Leghorns – the lowest (1297.45 ±10.25 g) ($p<0.05$). The best economic maturity was exhibited by White Leghorn group (135 days of age), whereas the Schijndelaar group attained economic maturity at 205 days of age. The most efficient feed conversion ($p<0.001$) for production of one egg and 1 kg egg mass was observed in group L (133.46±1.94 g and 2.19±0.05 kg/kg respectively). The highest hen-day egg production was recorded in group L and the lowest – in Schijndelaar (group S) and Araucana (group A). The weight of White Leghorn eggs was substantially higher ($p<0.001$) compared to eggs laid by Schijndelaars and Araucanas. The traits characterizing the economic efficiency of layer hens (feed conversion per egg produced and per 1 kg egg mass) in experimental groups were comparable to traits recorded in heavy egg-laying hybrids.

Key words: chicken eggs, eggshell colour, productive traits, Easter eggers

INTRODUCTION

Modern industrial production of eggs is based on intensive rearing of four-line hybrid layers. Depending on the eggshell colour, the stock layers are divided into two large groups: laying white-shelled and brown-shelled eggs. The difference in the productivity of the various crosses among the lines is reduced to a minimum, but combinations originating from White Leghorns are the leaders. Furthermore, consumers prefer more and more darker-shelled eggs of brown colour which results in change in selection parameters in some layer hybrids (1). Brown eggs are sought by consumers in the EC, Australia and New Zealand, where they are predominantly sold in retail stores (2, 3). The markets in the USA, Japan, Israel, Russia, Turkey, India, China etc. propose mainly white-shelled eggs, which are also less expensive. During the last decade, a certain interest to eggs with non-traditional colour of the shell: blue-green and dark brown, has emerged (3). According to Zhang (2007, cited by 4) hens laying green-pigmented eggs are not affected by trimethylaminuria, responsible for the unpleasant fish flavour of eggs.

The pigmentation of avian eggs is investigated since the second half of the 19th century, and the substances involved have been isolated and identified during the first half of the last century (5). The blue-green colour of eggs is

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due to a mutation determined by an autosomal dominant gene (6), which determines the deposition of biliverdin IX and biliverdin zinc chelate in the eggshell (7, 8). In domestic chickens, this coloration could be combined with various levels of protoporphyrin accumulation, rendering the colour of shells within the range from gray-green to dark olive green (8).

In some EC countries (Great Britain and Germany), some high production egg-laying hybrids for production of eggs with blue-green shells: Heritage Skyline (UK), Needwood Blue (UK), Fenton Blue (UK), Sapphire (UK), Gruneleger® (Germany). All British hybrids are created on the basis of the Cream Legbar. German Gruneleger® is created with the participation of Araucana and White Leghorn, and phenotypically resembles the Leghorns. In Japan, there are egg-laying hybrids for coloured eggs production, among which the most popular is the Blue egg layer G7. In the USA, attempts for production of similar hybrids on the basis of Araucana and White Leghorn are also made (9). The ban for rearing laying hens in conventional cages in the EU (10) and consumers' attitudes in member states for buying eggs from "happy chickens" (11, 12) would probably increase the interest towards eggs from Easter eggers.

Comparative investigations on the quality traits of eggs and their cholesterol content have been performed during the second half of the 20th century with the breed Araucana and commercial hybrids (13, 14). Sadjadi et al. (15) investigated the production traits and egg quality produced by F2 crosses between Araucana and Shaver Starcross "288", and found out lower egg production in crosses laying white eggs compared to those laying blue-green eggs, but no changes in egg quality. A PhD thesis has studied the performance of combinations between the Dutch decorative breed Schijndelaar and Rhode Island Red lines B and D from the National Genetic Fund of the Republic of Bulgaria (16-18). In China, the production traits and egg quality of Dongxiang chickens – recently of interest for commercial production of blue-green eggs, is investigated (4).

PURPOSE

The lack of sufficient body of evidence about the productive performance of laying hens producing blue-green-shelled eggs has set the goal - to investigate the productive traits of Araucana, Schijndelaar and White Leghorn breeds and their Easter egger crosses.

MATERIALS AND METHODS

The study was conducted with 5 groups of layers: 2 experimental and 3 control (**Figure 1**). Each group comprised 10 birds at the same age. They were reared in separate groups on deep litter, and fed compound feed according to the respective layer gen age category. The study period lasted from the onset of sexual maturity to 65 weeks of age.

As control groups, birds from the three original populations used as breeders were used: partridge Araucana (A) and Schijndelaar (S) as sire lines, and productive type White Leghorn (WL), as maternal line. The experimental groups were composed by crosses as followed:

♂ A × ♀WL
F1 – first experimental group (AWL)

♂ S × ♀WL
F1 - second experimental group (SWL)

The dynamics of egg production was followed out from the beginning of lay and age of 20% and 50% egg production to the end of the trial. The feed consumption and live weight of birds at age of 50% egg production were recorded.

The number of produced eggs was registered on a daily basis and obtained data were summarized for weekly periods. Egg weight was controlled on a weekly basis for each group. Once per week, feed intake was monitored for 3 consecutive days. On the basis of feed intake results, the following parameters were calculated: average weekly feed intake (g), feed intake per egg produced (g) and feed conversion (kg feed/kg egg mass). Live weight of birds was determined at the age of 20% and 50% egg production. Further weight measurements were not performed in order to reduce as much as possible the stress for birds.

The results were submitted to statistical analysis using classic statistical methods via the MS Excel 2010 software.

RESULTS AND DISCUSSION

The live weight of birds at age of 20% and 50% egg production is presented in **Table 1**. By the end of the growth, the Araucanas exhibited the highest live weight: 1408.25 ±19.25 g. Group L had a substantially lower average weight – 1297.45±10.25 g ($p<0.05$), and crossbred groups AWL and SWL occupied an intermediate position. This tendency was present as well at age of 50% egg production with respective values of 1588.25±21.65 g in group A and 1489.56±10.98 g in White Leghorns.

Figure 1. Experiment crossing scheme.

The analysis of data showed that in all groups except for group A, the variation of the live weight was low. The weights from both evaluations in White Leghorns were comparable to that from the technological specifications of the world high-production classical white egg-laying hybrids. The results in the Schijndelaar breed were similar to those obtained by us in 2013 – 1552.8±51.78 g at age of 50% egg production (Lukanov, unpublished results). This live weight was within the standard range for the breed: 1.5–2.0 kg (19). Due to the low egg production in this breed, the age at 20% egg production is accepted as economic maturity age. In Araucana chickens, live weight of sexually mature females varies from 1.6 to 2.0 kg (20). The recorded present values in the lower part of the weight range could be attributed to the big popularity of the breed and the different purpose of selection in the different lines. As anticipated, the two experimental groups had a live weight close to that of breeder forms and corresponding to recommended start weight for light egg-laying hybrids.

Table 1. *Live body weight of birds at age of 20% and 50% egg production, g.*

		Live body weight, g				
		L (1)	A (2)	S (3)	AWL (4)	SWL (5)
20% egg production	x	1297,45	**1408,25**	1358,65	1378,40	1328,60
	Sx	10,25	19,25	7,69	13,56	10,12
	significance	1:2***; 1:3***; 1:4***; 1:5*; 2:3*; 2:5***; 3:5*; 4:5**				
50% egg production	x	1489,56	**1588,25**	1524,70	1563,50	1503,20
	Sx	10,98	21,65	9,08	11,55	12,57
	significance	1:2**; 1:3*; 1:4***; 2:3**; 2:5***; 3:4**; 4:5***				

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Figure 2 depicts the age at 20% and 50% egg production in studied groups. As already stated for low-performance breeds Schijndelaar and Araucana, the age at 20% egg production was better for evaluation of economic maturity. The best economic maturity was expectedly established in White Leghorns: 128 days of age (20% egg production) and 135 days of age (50% egg production). Schijndelaars attained last the age of economic maturity: 171 and 205 days of age for 20% and 50% egg production, respectively. In this breed, the laying intensity increases very slowly, and the interval between the beginning of lay to 50% egg production was the longest – 34 days. In the other decorative breed – Araucana, this period was only 5 days. Probably, this result could be attributed to the influence of the low-performance breed Sumatra, which was used in the creation of the Schijndelaar breed. Even in its native land, Schijndelaars are rarely encountered and the maintenance of purebred birds presumes the appearance of inbreeding depression. An earlier study on the productive traits of the Schijndelaar breed demonstrated that the age at 20% egg production was 222 days, and at 50% egg production – 261 days (Lukanov, unpublished results). This difference in both studies could be explained with the different origin of birds in both experiments and the different feeding and rearing conditions during the growth period.

The economic maturity age of the two experimental groups is appropriate for their used for stock egg production – 142 days of age in group SWL and 145 days of age in group AWL. These values are close to characteristics of commercial egg-laying hybrids, which attain 50% egg production at about 140-150 days of age (21). This result could be explained by the stronger influence of the maternal line (White Leghorn) on the trait economic maturity age.

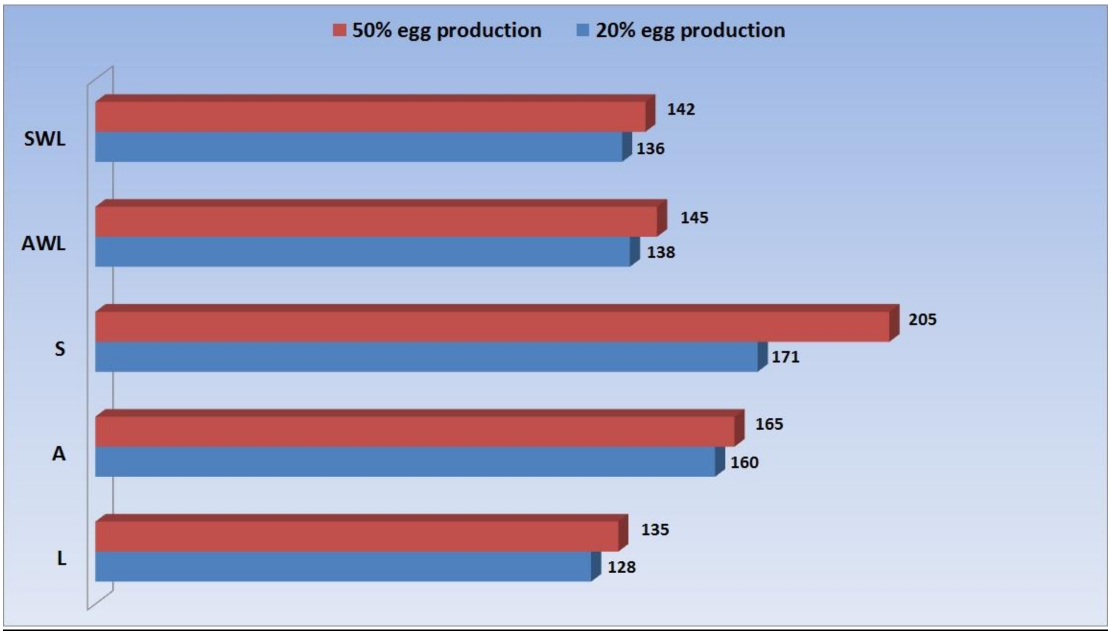

Figure 2. Age at 20% and 50% egg production.

The intake of feed from the five groups during the tested production period was similar, and the differences – small and insignificant **(Table 2).** The lowest feed intake was exhibited, as expected, by the groups A and S, which were outlined with low egg production and live weight. The other 3 groups as seen from the table had similar live weight, but a considerably higher egg production, which determined the higher needs from feed. The average daily feed intake of White Leghorns during the productive period was comparable to that of modern white egg-laying hybrids (21). The feed intake in the Schijndelaar breed established by Lukanov (unpublished data) was also within a similar range: 113.07±0.93 g daily during the productive cycle.

Table 2. *Average feed intake, feed intake per egg produced and FCR, g.*

group	Feed intake, g			Feed intake, g/egg°			FCR, kg/kg °		
	x± Sx	VC,%	Significance	x± Sx	VC,%	Significance	x± Sx	VC,%	Significance
L (1)	111,04 ±0,96	6,00	NS	**133,46± 1,94**	9,86	1:2,3,4,5***; 2:3,4,5***; 3:4,5***; 4:5*;	**2,19± 0,05**	16,94	1:2,3,4,5**; 2:3,4,5***; 3:4,5***; 4:5*
A (2)	108,39 ±1,28	8,16		231,17± 5,34	14,80		4,37± 0,09	13,40	
S (3)	109,99 ±0,87	5,48		325,04± 14,65	26,67		7,01± 0,29	25,45	
AWL (4)	110,96 ±0,87	5,60		148,32± 1,59	7,10		2,56± 0,04	9,33	
SWL (5)	**111,16 ±0,89**	5,56		153,57± 1,50	6,48		2,70± 0,05	13,45	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

° the referred summary data do not include the first productive month.

In **Table 2**, the data for feed conversion during the first productive month were not taken into consideration as the laying intensity and the weight of eggs was still low. The feed conversion for production of one egg (g/egg) and for production of one kilogram of egg mass (kg/kg) was the most efficient in group L (133.46±1.94 g and 2.19±0.05 kg/kg) ($p<0.001$), and the least efficient in group S (325.04±14.65 g and 7.01±0.29 kg/kg). Feed conversion per 1 kg egg mass in Schijndelaars was more than 3 times more inefficient than those of the other groups because of the low egg production and low egg weight. Although the daily feed intake in Araucana chickens was lower, the economic traits feed conversions per egg and per kg egg mass were worse as compared to the maternal form and to crosses by reason of the lower egg production and egg mass. In control groups S and A, the variations in these two signs were the greatest consequently to the irregular egg laying intensity during the experimental period.

According to the study, feed conversion per egg and per kg egg mass in the two experimental groups was similar to those in heavy egg-laying and all-purpose hybrids (21). This is promising in order to the more detailed breeding work with the tested breeder combinations.

During the entire period of the study, no deaths have occurred in both experimental and control birds. This entailed no differences between hen-housed and hen-day egg production. The hen-day egg production is considered as the most accurate parameter for the egg production potential of birds.

Figure 3 presents the data about hen-day egg production during the productive period and the predicted annual egg production (the equivalent of 365-day production cycle).

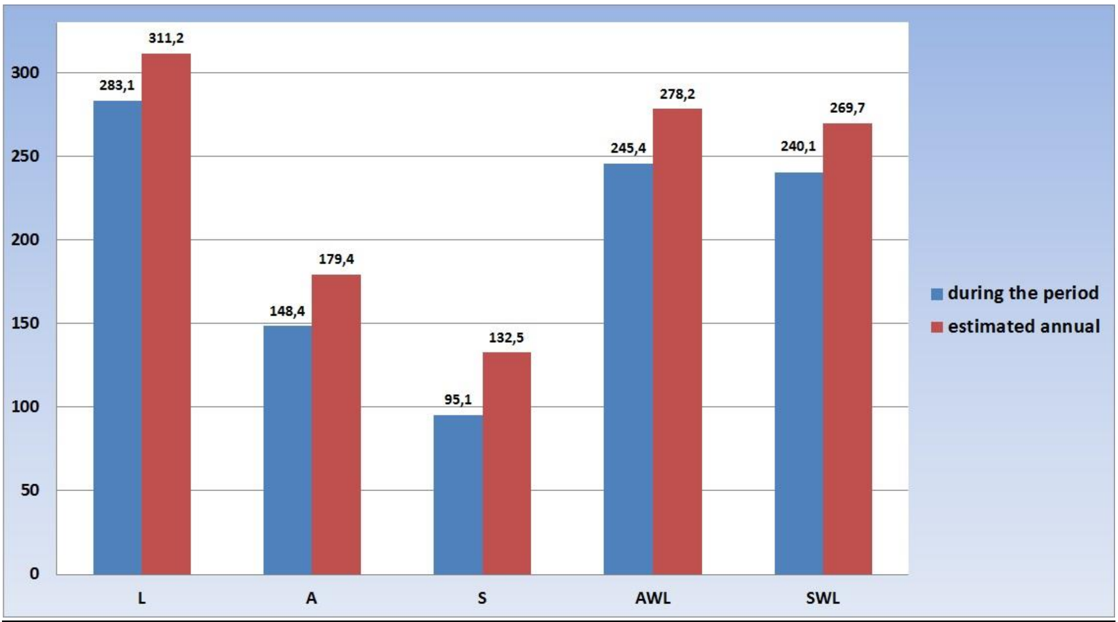

Figure 3. Hen-day egg production during the productive period and the predicted annual egg production, egg number.

The necessity from the predicted annual egg production issues from the fact that the monitored productive period in all five groups was shorter. The highest hen-day egg production was observed in group L with 283.1 eggs laid until 35 weeks of age and predicted annual egg production of 311.2 eggs that is corresponding to modern accomplishments of high-producing lines of this breed (21). The lowest egg production was registered in decorative breeds Schijndelaar (S) – 95.1 eggs (predicted annual production 132.5 eggs) and Araucana (A) with 148.4 eggs (predicted annual production 179.4 eggs). In a previous study of ours (Lukanov, unpublished data) estimated hen-day egg production in the Schijndelaar breed was 140.5 eggs, comparable to the present predicted yield. In the available literature, the average annual egg production for Araucana chickens is reported to be about 180 eggs (20), which is in line with the present results. The two experimental groups exhibited a strong heterosis effect induced by the maternal line with regard to this trait. Their productivity was similar to that of White Leghorns. A predicted annual egg production of 270-280 eggs from Easter eggers is a promising result, which could be further expanded with inclusion of other breeder combinations.

In modern egg-laying hybrids, laying intensity throughout the productive period is more than 75-80% with a peak of 94-96%. In our conditions, the highest average laying intensity was established, as anticipated, in group L (84.68±1.4%), while the lowest – in group S (35.64±1.5%) ($p<0.001$). With respect to this trait, the two experimental groups showed a marked heterozis effect originating from the maternal form: 75.05±1.4% for AWL and 72.15±1.6% for SWL.

Figure 4 presents the dynamics of change in egg-laying intensity during the experimental productive period.

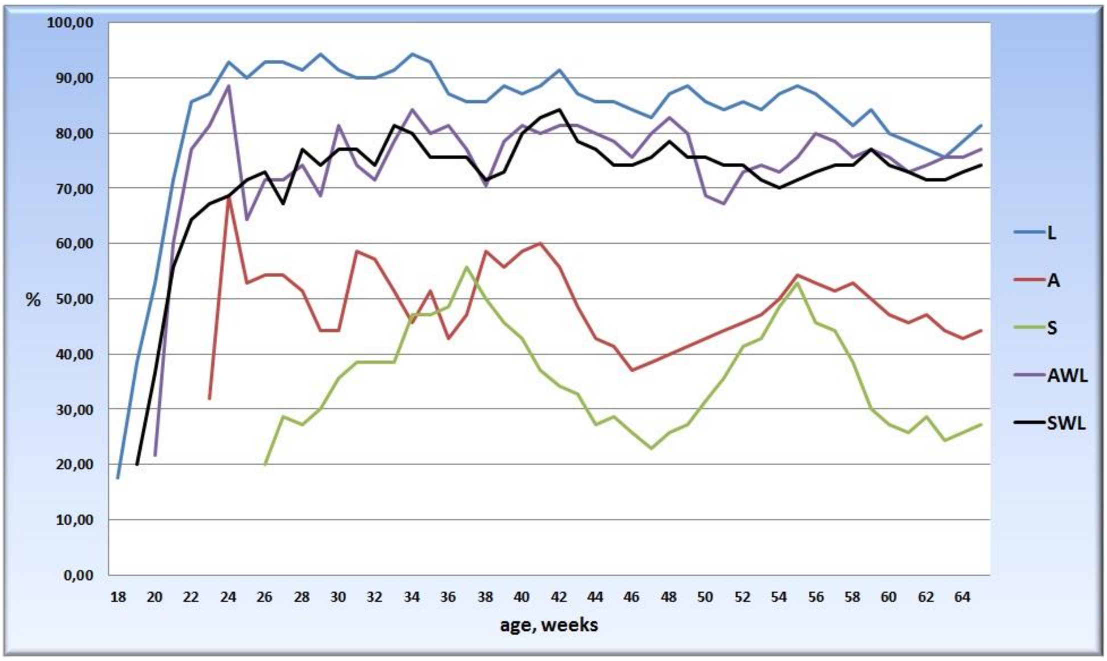

Figure 4. Egg-laying intensity, %.

In all groups, except for groups A and S, there was a sharp increase in production curve during the first 3 productive weeks with peak values between the 23rd and 34th weeks of age maintaining a stable trend until the end of the trial. In groups AWL and SWL, the shape of laying intensity curves was typical for the egg laying cycle of modern highly productive layers. In comparison with the curve of group L, which was distinguished with the lowest undulations, whereas in both experimental groups there were more serious and obvious depressions and peaks, a consequence to their choleric temperament. In group S, the laying intensity curve showed a slow but steady trend towards increase, but here, the time for attaining the peak levels was significantly longer as compared to the other groups (highest peak value during the 37th week: 55.71% and a second peak during the 55th week: 52.86%). The highest peak values were those of group L during the 29th and the 34th weeks of age – 94.3%. In White Leghorns, egg production was kept higher than 80% until the 60th week of age, and until the end of the experimental period was >75.7%. For group AWL, the peak values of 88.57% were attained at 24 weeks of age. The SWL group attained a high laying intensity at 33-34 weeks of age – 81.43%. After that time, the laying intensity decreased and was below 70%, then increased by the 42nd week to the highest percentage of 84.29%. Peak egg production of both control sire lines A and S occurred at 24 and 37 weeks of age with values of 68.7% and 55.7%, respectively.

On the basis on afore mentioned facts, it could be summarized that egg laying intensity in group L was distinguished with the most stable trend. The egg-laying curves of groups A and S are very dynamic by reason of their purpose, resistance to stress and their strong brooding instinct. Egg-laying curve characteristics similar to those of group L were demonstrated in the two experimental groups, but they were considerably more dynamic with higher peaks and depressions, more pronounced in the AWL group.

The average egg weight has an effect on egg costs and could be partly adjusted by the content and amount of feed depending on market conjuncture. Hereditary factors: breed/strain and age, however, are the primary ones. **Table 3** presents the results about average egg weight throughout the entire experimental period. Group L had the highest average egg weight – 60.87±1.54 g, whereas group S – the lowest – 46.62±0.45 g ($p<0.001$).

In group AWL, egg weight was close to the mean arithmetic between maternal and paternal lines (56.66±1.65 g). In group SWL, egg weight was considerably higher than the sire line (group S), with values close to those in the other experimental group. The variation of the sign in crossbred layer was higher as compared to controls, where group S exhibited the lowest coefficient of variation (CV=3.07%). The weight of White Leghorn eggs until 65 weeks of age corresponded to modern standards for white egg-laying hybrids. With respect to standard ranges of egg weight in Araucana and Schijndelaar breeds, there were also no deviations (3; Lukanov, unpublished data). The egg weight in experimental groups could be further improved. This trait could be influenced positively via purposeful selection for sire lines with heavier eggs or inclusion of a breed laying larger eggs (Cream Legbar).

Table 3. *Average egg weight, g.*

group	L (1)	A (2)	S (3)	AWL (4)	SWL (5)
x	**60,87**	52,16	<u>46,62</u>	56,66	55,96
Sx	1,54	0,88	0,45	1,65	2,07
VC,%	8,39	5,35	3,07	9,65	12,24
Shell color	white	light blue-green	light blue-green	light blue-green	light blue-green
significance	1:2,3***; 2:3***; 2:4*; 3:4,5***				

* p< 0.05 ** p< 0.01 *** p< 0.001

CONCLUSION

- In the beginning of the experiment, Araucana chickens had the highest average live weight. Group L had the lowest live weight, while the crossbred groups AWL and SWL occupied an intermediate position. This trend was preserved during the entire study period.
- White Leghorns attained maturity at the earliest age, whereas the onset of maturity in Schijndelaars occurred most lately.
- The most efficient feed conversion for production of an egg and of 1 kg egg mass was established in group L, while the least efficient – in group S.
- The highest hen-day egg production was demonstrated in group L, and the lowest – in decorative purebred Schijndelaar (S) and Araucana (A) chickens.
- In the present study, group L was characterised with the highest average egg-laying intensity, and group S – with statistically significantly lowest (p<0.001).
- The weight of eggs in White Leghorns was substantially higher (p<0.001) than those in decorative Schijndelaar and Araucana breeds.

RECOMMENDATIONS

According to the results from the present study, the tests on combinations between several breeds for production of Easter eggers laying blue-green eggs are promising for continuation of the selection work. Other breeds laying eggs with biliverdin pigmentation should be preferably tested as breeder forms in the production of modern egg-laying hybrids. Thus, the most appropriate breed and combinations could be included in hybrid schedules for obtaining highly-producing Easter eggers.

REFERENCES

1. Cavero, D., Schmutz, M., Icken W. and Preisinger, R., Attractive Eggshell Color as a Breeding Goal. *Lohmann Information*, 47 (2): 15-21, 2012.
2. Odabaşi, A. Z ., Miles, R. D., Balaban, M. O. and Portier, K. M., Changes in brown eggshell color as hen ages. *Poultry Science*, 86:356 – 363, 2007.
3. Lukanov, H. Petrov, P. and Gerzilov, V., Possibility to produce eggs with different colored egg-shell under free range and organic production. *Ptitsevudstvo*, 4: 6-9, 2012. BG.
4. Wang, X. L., Zheng, J. X., Ning, Z. H., Qu, L. J., Xu, G. Y. and Yang, N., Laying performance and egg quality of blue-shelled layers as affected by different housing systems. *Poultry Science*, 88 :1485–1492, 2009. doi: 10.3382/ps.2008-00417.
5. Lang, M.R. and Wells, J.W., A Review of eggshell pigmentation. *World's Poultry Science Journal*, 43 (03): 238-246, 1987.
6. Punnett, R. C,. Genetic studies in poultry, IX. The blue egg. *Journal of Genetics*. 27:465-470, 1933.
7. Poole, H.K., Egg shell pigmentation of Japanese quail: Genetic control of the white egg trait. *Journal of Heredity*, 55 (3): 136–138, 1964.
8. Kennedy, G.Y. and Vevers, H.G., A survey of avian eggshell pigments. *Comparative Biochemistry and Physiology, Part B: Comparative Biochemistry*, 55 (1): 117-123, 1976.

9. Lukanov, H., Blue-green coloured eggs in Gallus gallus domesticus. *Agricultural Science and Tehnology*, 6(1): 3-10, 2014.
10. Lukanov, H., Petrov, P. and Gerzilov, V., Exterior characteristics of introduced breeds of chickens suitable for free range and organic production. *Ptitsevudstvo*, 1, 6-12, 2013. BG.
11. Commission of the European Communities (CEC)., Council Directive 1999/74/EC: laying down minimum standards for the protection of laying hens. *Official Journal of the European Communities*, L 203, 53–57, 1999. European Community, Brussels.
12. Van Horrne, P.L.M., The impact of laying hen welfare on the competitiveness of the EU egg industry. *World Poultry*, 19 (10), 18-21, 2003.
13. Van Horne, P.L.M., and Achterbosch, T.J., Animal welfare in poultry production systems: impact of EU standards on world trade. *World's Poultry Science Journal*, 64, 40-52, 2008.
14. Somes, R. G. Jr., Francis P. V., and Tlustohowicz J. J., Protein and cholesterol content of Araucana chicken eggs. *Poultry Science*, 56:1636–1640, 1977.
15. Peterson, D. W., Lilyblade A., Clifford C. K., Ernst R., Clifford A. J. and Dunn P., Composition of and cholesterol in Araucana and commercial eggs. *Journal of the American Dietetic Association*, 72:45–47, 1978.
16. Sadjadi, M., Renden J. A., Benoff F. H. and Harper J. A., Effects of the blue eggshell allele (O) on egg quality and other economic traits in the chicken. *Poultry Science*, 62: 1717 – 1720, 1983.
17. Lukanov, H., Genchev, A., Combinational capabilities between B and D lines of the RIR breed as maternal forms and Shijndelaar breed as a paternal form. First stage – growing period. *Ptitsevadstvo*, 6:14-18, 2012. BG.
18. Lukanov, H., Genchev, A., 2013. „Eggs color characteristics with a blue-green shell pigmentation ". *Vth International Scientific and Practical Conference „Preserving the diversity of animals and hunting economy Russia- 2013*", pp: 543-545, Moscow, 2013. RU.
19. Lukanov, H., Genchev, A., Dimov D. and Penchev I.G., Egg quality characteristics of crosses between Scijndelaar and B and D line of the Rhode Island Red breed. *Ptitsevadstvo*, 2014, 4, pp: 4-8, 2014. BG.
20. KLN.**,** Standaard van hoender- en dwerghoenderrassen. *Kleindier Liefhebbers Nederland*, 2010.
21. EE., Rassegeflügel-Standard für Europa (in Farbe)**.** *BDRG*, Germany, 2010.
22. Kabakchiev, M., Proizhod, porodi i hibridi kokochki. In Pticevudstvo (Kabakchiev M and Gerzilov V, edditors). Plovdiv, pp: 203-209, 2014. BG