

## QUALITY OF EGGS FROM PASTURE REARING LAYERS OF DIFFERENT GENOTYPES

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**Abstract:** The comparison of physical quality properties of table eggs of commercial hybrid Tetra SL and two native indigenous breeds of hens, Banat Naked Neck and Svrlijig hen, was performed in conditions of alternative production in the pasture system in portable cages without the floor. The experiment was conducted during the vegetation period, at the age of hens of 53-57 weeks. In order to produce good quality eggs, the diet was designed with a complete mixture based on maize and soybean. In addition, constant availability of pastures was ensured. Egg sampling was performed in the morning and the initial egg quality was examined based on egg weight, shape index, egg white, egg yolk and shell quality parameters. Layer hens of the commercial hybrid Tetra SL had significantly higher egg weight and better internal egg quality ( $p < 0.01$ ) compared to hens of Banat Naked Neck and Svrlijig hens, except for the colour of the yolk, which was more intense in the same feeding and breeding conditions and the age of laying hens, in eggs of native breeds ( $p < 0.01$ ). Native breeds in relation to the commercial hybrid had lighter shell colour ( $p < 0.01$ ). Deformation and egg shell thickness differed ( $p < 0.01$ ) between all three genotypes. The determined rank of layer hen genotypes for shell thickness was: Tetra SL, Banat Naked Neck, Svrlijig hen. However, the breaking force was without statistically confirmed difference between hen genotypes.

**Key words:** egg quality, genotype, native breeds, alternative production

## Introduction

The acceptability of table eggs on the market is increasingly influenced by the level of welfare of laying hens, as well as the quality and safety of the product itself for consumers. Related to this is the consumer interest in poultry farming systems (Rodić et al., 2010; Tolimir et al., 2019). Free range, according to the results of survey research of consumer attitudes, is a more acceptable breeding system compared to commercial cage and other systems because it provides more natural conditions for egg production that are more desirable (Pavlovski et al., 2011). Numerous studies of the effect of breeding systems on egg quality have different, often inconsistent results (Sekeroglu et al., 2010; Englmaierova et al., 2014; Yenice et al., 2016; Kucukkoyuncu et al., 2017; Škrbić et al., 2019). Accordingly, Holt et al. (2011) find that a number of factors, including breed or genotype, should be considered in terms of understanding the effects on egg quality and safety before switching to any of the alternative farming systems.

Genetic conditionality of egg quality traits is known. Hybrid layer hens in intensive and controlled growing conditions show a high level of genetic potential for egg weight, egg shell and egg white quality. However, certain traits of egg quality, in addition to the genetic basis, are under the primary influence of diet and breeding conditions (Rakonjac et al., 2014). Native, unselected hens are characterized by higher adaptive abilities necessary for free range production and thus lower requirements in terms of breeding conditions. Their genetic potential for production is significantly lower compared to hybrid layers (Škrbić et al., 2011).

Alternative production systems have long been in the focus of researchers, as well as finding opportunities for the self-sustainability of native, indigenous breeds through the production of biologically valuable food. In this regard, research on local native breeds of hens is increasingly present, both in terms of morphological and production characterization (Milošević et al., 2013; Teneva et al., 2015), and in terms of various aspects of product quality (Pavlovski et al., 2011; 2013; Mitrović et al., 2011; Stanišić et al., 2015), while few studies (Pavlovski et al., 2012; Sokolowicz et al., 2018) investigate the physical characteristics of egg quality of native hen breeds.

Starting from the known effects of layer genotype and breeding system on individual egg quality traits, the aim of the study was to compare the physical quality traits of eggs from hybrid layers and two native, indigenous hen breeds and determine the level of these differences in one of the forms of alternative production, i.e. pasture breeding system in portable cages.

## Material and Methods

The hens of the Tetra SL hybrid and two native, autochthonous breeds: the Banat Naked Neck and Svrlijig hens, were reared in portable cages, without a floor, on natural pasture. The experiment was conducted during the vegetation period, May-June, at the Institute of Animal Husbandry in Belgrade, at the age of hens of 53-57 weeks. The area of the cage was 4.5 m<sup>2</sup> and the stocking density was 3 layers/ m<sup>2</sup>. There were a total of 6 cages, or 30 layer hens per each genotype. The cages were equipped with a feeder, drinker, nests and perches. The birds in the cages were protected from adverse weather conditions. The layers were exposed to natural light for the duration of 15 hours. Given the nutrient requirements of layer hens, necessary for the production of good quality eggs, and limiting pasture area, the diet was adapted to the most demanding, hybrid hen and was made with a complete mixture based on maize and soybean, with the metabolic energy content of 11.5MJ/kg, 16,4% crude protein content, 0.8% lysine, 0.4% methionine, 3.9% calcium and 0.38% digestible phosphorus. In addition, in order to ensure constant availability of pastures, the cages were moved over the pasture surface. Food and water were available to the layers ad libitum. Egg sampling was performed in the morning and the initial egg quality was examined based on the properties of external and internal egg quality (Pavlovski *et al.*, 1997) and egg shell quality (Pavlovski and Vitorović, 1996) in 3 replications with 30 eggs per treatment.

Statistical data processing was performed by variance analysis One-way ANOVA using the statistical software package STATISTICA, version 8, StatSoft, Inc. ([www.statsoft.com](http://www.statsoft.com)).

## Results and Discussion

The effect of genotype on egg weight, shape index and internal egg quality parameters in the three age periods of layer hens, as well as the average for the examined period, is shown in Table 1. The presented egg quality parameters indicate significant difference between hybrid Tetra SL and native hen breeds.

Differences in quality traits that are under the dominant influence of genotype, i.e. selection progress of hybrid layers, are more pronounced in relation to native, unselected hens. The egg weight, on average for the test period, was 64.62 g in Tetra SL laying hens, and in native hens 55.1 and 55.6 g, respectively. The shape index indicates a more rounded shape of the eggs from hybrid layers compared to the native breeds, which is the result of genetic improvement and aims to reduce egg breakage. Haugh Units, according to egg white height, were with insignificant differences between Svrlijig hen and Banat Naked Neck (68.48 vs. 67.82) and significantly ( $p < 0.01$ ) higher in Tetra SL eggs. Eggs of the examined

native breeds of hens had significantly ( $p < 0.01$ ) more intense coloration of the yolk compared to Tetra SL laying hens in pasture feeding conditions.

**Tabela 1. Egg quality parameters (mean  $\pm$  SD)**

Genotype/ Age/ Parameter	Tetra SL				Banat Naked Neck				Svrljig hen			
	53	55	57	53-57	53	55	57	53-57	53	55	57	53-57
Egg weight, g	66.97 5.31	66.53 5.89	60.35 4.41	64.62 <sup>A</sup> 5.98	55.38 2.72	55.02 3.56	54.96 2.57	55.10 <sup>B</sup> 2.96	55.75 5.27	55.53 6.72	54.81 5.32	55.60 <sup>B</sup> 5.72
Shape index	77.35 2.58	76.75 2.45	77.40 2.95	77.17 <sup>A</sup> 2.64	73.50 2.09	74.55 3.03	74.74 1.91	74.31 <sup>B</sup> 2.44	74.50 2.46	73.25 2.02	74.05 2.87	73.93 <sup>B</sup> 2.49
Albumen height 0.1mm	82.05 15.04	79.00 10.02	74.25 17.95	78.43 <sup>A</sup> 14.81	52.50 19.17	53.50 17.48	47.47 8.55	51.13 <sup>B</sup> 15.53	52.45 10.39	48.20 12.11	47.45 11.61	49.37 <sup>B</sup> 11.42
Yolk colour (Roche)	13.25 0.64	12.85 0.59	11.15 0.49	12.42 <sup>B</sup> 1.08	13.50 0.73	13.25 2.07	13.58 0.69	13.44 <sup>A</sup> 1.36	13.30 0.66	13.45 0.51	13.25 0.64	13.33 <sup>A</sup> 0.60
Egg white/yolk ratio	2.02 0.22	2.11 0.21	1.99 0.19	2.04 <sup>A</sup> 0.21	1.56 0.17	1.51 0.19	1.56 0.16	1.54 <sup>B</sup> 0.17	1.44 0.28	1.50 0.24	1.42 0.25	1.45 <sup>B</sup> 0.25
HU	87.20 9.66	86.20 5.80	83.85 11.55	85.75 <sup>A</sup> 9.27	69.44 15.75	66.95 17.01	67.37 7.75	67.82 <sup>B</sup> 13.85	71.10 8.94	67.50 9.06	66.85 9.59	68.48 <sup>B</sup> 9.24

A-B - average values of parameters for examined period in each row without a common designation are significantly different at the level of 1%

These results show consistency with the research of *Svobodova et al. (2014)* who examined the quality of Czech hen and Lohmann White eggs, in a cage and floor rearing system, found a significant genotype effect and significantly higher values of egg weight, egg shell weight and better egg white quality of eggs from Lohmann White hens. Contrary to our results, the Czech hen shape index is higher compared to Lohmann White. According to *Sokolowicz et al. (2018)*, the internal quality of eggs of hybrid layer hens in the free range system shows a significantly higher value compared to the eggs of the Polish native breed of hens (Greenleg Partridge hens) in the same breeding system. *Krawczyk (2009)* states that in unselected native hens, the quality of eggs changes in relation to the level of production and age of the layer hens and that there is a difference in relation to the patterns present in commercial hybrid layer hens. Accordingly, the research of *Škrbić et al. (2011)* shows that, despite the generally poorer quality of eggs of Banat Naked Neck hen, the internal quality of eggs is more stable in relation to the age of the laying hens and that the differences in the level of correlation of certain egg quality traits and laying age conditions favour their prolonged exploitation in conditions of alternative production compared to hybrid layers.

Significantly higher ( $p < 0.01$ ) egg white to yolk ratio of Tetra SL hens (2.04) compared to hens of Banat Naked neck (1.54) and Svrlijig hens (1.45) indicates a significantly higher share of yolks in eggs of native breeds of hens. It is known that native breeds of hens accumulate higher fat deposits compared to hybrid layers (*Stanišić et al., 2015*), which is associated with differences in productivity of these layers (*Rizzi and Chiericato, 2010*). The more intense coloration of egg yolks of Polish native hens (*Sokolowicz et al., 2018*) in the free range system compared to hybrid layers from the same systems, as well as Czech hen (*Svobodova et al., 2014*) in the cage and floor breeding system, confirm the effect of genotype, in accordance with our results, and indicates that this trait of yolk quality is not necessarily related to the availability of pastures, i.e. nutrition.

The effect of genotype on egg shell quality parameters in three age periods of laying hens, as well as the average for the examined period, are shown in Table 2. Based on the presented results, it can be concluded that, in addition to differences between Tetra SL and native hens, significant differences in egg shell quality were also found between the autochthonous breeds of Banat Naked neck and Svrlijig hens.

The egg shell weight was significantly higher ( $p < 0.01$ ) in Tetra SL eggs compared to eggs of native hens, in line with the egg weight. Genetically determined, the colour of the egg shell of native hens was significantly lighter compared to hybrid layer hens of brown eggs (1.64 and 1.80 to 3.57). The cleanliness of the shell in all three hen genotypes was at a satisfactory level with established differences between Tetra SL laying hens and Svrlijig hens at the level of  $p < 0.05$ , i.e. Tetra SL and Banat Naked Neck, at the level of  $p < 0.01$ . According to the legal provisions (*Rulebook on the quality of eggs, 2019*), eggs for consumption placed on the market must not be washed or cleaned in any other way, which emphasizes the importance of achieving a high level of egg cleanliness from alternative systems. The results of the experiment confirm the possibility that a satisfactory level of shell cleanliness can be achieved in the pasture system, which was over 4 points for all three hen genotypes, but with significant differences in the manifestation of this trait.

Other properties of egg shell quality, apart from the breaking force, showed differences between all three examined genotypes. Eggs from Svrlijig hens had significantly lower shell deformation compared to Banat Naked Neck ( $p < 0.01$ ) and on the other hand, significantly higher compared to Tetra SL hens ( $p < 0.01$ ). Accordingly, the egg shell thickness was determined, on the basis of which the following rank of the examined hen genotypes can be determined: Tetra SL, Svrlijig hen, Banat Naked Neck.

**Table 2. Egg shell quality parameters (mean ± SD)**

Genotype/ Age/ Parameter	Tetra SL				Banat Naked neck				Svrljig hen			
	53	55	57	53-57	53	55	57	53-57	53	55	57	53-57
Egg shell colour points	3.70 0.57	3.45 0.51	3.55 0.60	3.57 <sup>A</sup> 0.56	1.50 0.63	1.75 0.72	1.63 0.68	1.64 <sup>B</sup> 0.68	1.90 0.55	1.90 0.55	1.60 0.60	1.80 <sup>B</sup> 0.58
Egg shell cleaniness points	4.70 0.73	5.00 0.00	4.75 0.91	4.82 <sup>Aa</sup> 0.68	4.25 1.29	4.65 0.75	3.74 1.41	4.22 <sup>Bb</sup> 1.21	4.50 0.95	4.60 0.94	4.90 0.31	4.67 <sup>ABb</sup> 0.80
Egg shell deformation 0.001mm	22.05 4.14	21.25 2.63	21.60 2.50	21.63 <sup>C</sup> 3.14	27.88 5.84	31.84 6.45	33.00 7.73	31.07 <sup>A</sup> 6.98	24.35 4.23	25.20 3.49	28.58 5.82	26.00 <sup>B</sup> 4.87
Egg shell weight, g	9.45 0.77	9.14 1.08	8.30 0.98	8.96 <sup>A</sup> 1.05	6.93 0.77	6.64 0.81	6.12 0.53	6.54 <sup>B</sup> 0.77	6.95 0.74	6.98 0.84	6.57 0.64	6.83 <sup>B</sup> 0.75
Egg shell thickness 0.01mm	33.70 3.40	32.55 7.23	33.95 2.42	33.40 <sup>A</sup> 4.78	29.44 2.71	27.85 2.81	27.47 2.37	28.18 <sup>C</sup> 2.72	30.50 2.56	30.90 2.73	28.60 2.41	30.00 <sup>B</sup> 2.72
Breaking force, kg	2.40 0.41	2.46 0.35	2.44 0.51	2.43 <sup>A</sup> 0.42	2.17 0.41	1.93 0.34	1.88 0.28	1.98 <sup>B</sup> 0.36	2.29 0.33	2.16 0.36	1.96 0.65	2.14 <sup>B</sup> 0.48

a-b - average values of parameters for examined period in each row without a common designation are significantly different at the level of 5%; A-B - average values of parameters for examined period in each row without a common designation are significantly different at the level of 1%

The breaking force, which is also an indicator of the structural quality of the egg shell, was 2.43; 2.14 and 1.98 kg for Tetra SL, Svrljig hen and Banat Naked Neck. The obtained results confirm the poorer quality of the eggshell of the Banat Naked Neck in relation to other native breeds of hens (*Pavlovski et al., 2012*). *Škrbić et al. (2011)*, in a previous study, has found similar values of the quality parameters of the eggshell of a Banat Naked Neck aged 52 weeks. Contrary to this, the results of *Sokolowicz et al. (2018)* on the determined higher values of egg shell thickness of native breed eggs in relation to hybrid layer hens, while differences in shell strength were not statistically confirmed.

## Conclusion

In the alternative production of table eggs, in pasture conditions, the laying hens of the commercial hybrid Tetra SL had significantly higher egg weight and better egg quality compared to Banat Naked Neck and Svrljig hen, except for the egg yolk colour which, in the same conditions of feeding and rearing, as well as layer age, was more intensive in eggs of native breeds. The genetically conditioned lighter color of the egg shell of native unselected hen breeds compared to hybrid layer hens has been confirmed. Differences between all three genotypes were found

in egg shell deformation and thickness. The determined rank of layer genotypes for egg shell thickness was: Tetra SL, Banat Naked neck, Svrlijg hen. However, the breaking force was without statistically confirmed difference between hen genotypes.

The results of the research indicate the possibility of producing table eggs of good quality in conditions of limited pasture areas, as well as the use of commercial hybrid layer hens in the mentioned alternative breeding system. From the aspect of native hen breeds, the results represent a contribution to the study of physical characteristics of egg quality of these breeds in the general perception and understanding of their the needs and possibilities for their improvement, in order to increase acceptability from consumers and producers. Based on that, in the future, it would be possible to base the conservation of genetic resources on the principle of self-sustainability through the production of eggs for consumption.

## **Kvalitet jaja kokoši nosilja različitog genotipa gajenih na pašnjaku**

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### **Rezime**

Komparacija fizičkih osobina kvaliteta konzumnih jaja kokoši komercijalnog hibrida Tetra SL i dve nativne autohtone rase kokoši, banatska gološijanka i svrljiška kokoš, izvršena je u uslovima alternativne proizvodnje u pašnjačkom sistemu gajenja u portabl kavezima bez poda. Ogled je sproveden u toku vegetacionog perioda, u uzrastu kokoši 53-57 nedelja. U cilju proizvodnje jaja dobrog kvaliteta, ishrana je vršena kompletnom smešom na bazi kukuruza i soje. Pored toga, obezbeđena je konstantna dostupnost pašnjaka. Uzorkovanje jaja je bilo u jutarnjim satima i ispitivan je inicijalni kvalitet jaja baziran na masi jajeta, indeksu oblika, parametrima kvaliteta belanca, žumanca i ljuske. Nosilje komercijalnog hibrida Tetra SL su imale značajno veću masu jajeta i bolji unutrašnji kvalitet jaja ( $p < 0.01$ ) u odnosu na kokoši banatske gološijanke i svrljiške kokoši, osim boje žumanca koja je u istim uslovima ishrane i gajenja, kao i uzrasta nosilja, bila intenzivnija kod jaja nativnih rasa ( $p < 0.01$ ). Nativne rase u odnosu na komercijalni hibrid imaju svetliju boju ljuske ( $p < 0.01$ ). Deformacija i debljina ljuske su se razlikovale ( $p < 0.01$ ) između sva tri genotipa. Utvrđeni rang genotipova nosilja za debljinu ljuske je bio: Tetra SL, banatska gološijanka, svrljiška kokoš.

Međutim, sila loma je bila bez statistički potvrđene razlike između genotipova kokoši.

**Ključne reči:** kvalitet jaja, genotip, native rase, alternativna proizvodnja

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