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COMPARATIVE CHARACTERISTICS OF EGGS OF CHICKENS OF DOMESTIC AND FOREIGN SELECTION IN THEIR DIVERSE AGE

Lyudmyla Nalyvayko, Kateryna Rodionova, Svitlana Pankova, Natalia Shomina, Oleg Katerynych, Mariia Khimych

ABSTRACT
At this juncture, more and more attention is drawn to the preservation of the gene pool of local breeds of poultry, which have a set of valuable features, including high-quality eggs. In this study, the quality parameters of eggs (egg weight, weight, and proportion of yolk, weight, and proportion of albumen, yolk-albumen ratio, energy value, lipid and fatty acid content in the yolk) of chickens of Ukrainian selection(such hybrids as Plymouth white, Poltava Clay, Birkivska Barvysta and their interbreed hybrids) and foreign commercial crosses (Tetra SL, Tetra H, Super Harko, Lohmann Brown, Highsex White and Brown, High Line W36), at different ages (26, 34, 44 weeks of age) were studied in the comparative aspect. The average egg weight of Ukrainian breeds and hybrids was 51.9 g, 56.5 g, and 61.2 g at the age of 26, 34, and 44 weeks, respectively, in foreign crosses it was much higher – 59 g, 61.2 g, and 64.5 g, respectively (p <0.01). At the same time, there was a probable advantage of the Ukrainian selection bird over the foreign selection bird in the proportion of yolk (by 4.3%, 2.9%, and 4.1% at the age of 26.34 and 44 weeks, respectively), the yolk-albumen ratio (by 0.12, 0.07 and 0.08, respectively) and the energy value of the egg (76, 48 and 60 kJ, respectively). Higher lipid content was found in the egg yolks of domestic chickens in comparison with the foreign hybrid Tetra SL. The total content of saturated and unsaturated fatty acids in the egg yolks in hens of local breeds is higher than in foreign cross. High-quality characteristics of eggs of local breeds and populations are evidence of the presence of a valuable set of genes that require comprehensive study, preservation, and use in the creation of new selectively significant forms.

Keywords: egg; line; physical quality; morphological quality; lipid

INTRODUCTION
The egg composition, especially the content of amino acids and fatty acids, is crucial for embryo development **(Hammershøj and Johansen, 2016)**. Energy and nutrients needed for the development of chicken embryos are mainly provided by nutrients that are stored in eggs. Egg yolk provides 90% of the energy needed for embryonic development in the form of fatty acids **(Haron et al., 2017; Zhu et al., 2020)**. The main part of the dry matter of egg yolk consists of lipids (over 60%), which are the main source of energy for embryos **(Yadgary et al., 2013)**.

Lipid metabolism during the embryonic development of birds is characterized by certain features. In particular, a chicken embryo, which is contained in the yolk of a fertilized egg for 21 days, develops in a closed environment **(Surai, Fisinin and Karadas, 2016)**. During embryonic development, complex physiological and biochemical processes take place in the egg between the embryo, yolk, protein, and shell. In the early stages of development, the embryo assimilates yolk substances, including lipids, and uses them as a flexible material and energy source **(Duh, Vovk and Martsynovskyi, 2017)**.

It is known that the energy value of lipids is twice as high as proteins and carbohydrates, so lipids are one of the main sources of energy. The lipids in egg yolk are mainly presented by phospholipids and triacylglycerols, after their hydrolysis by lipolytic enzymes they are used as a structural and energy material. Fatty acids mainly linoleic, oleic, stearic, and palmitic ones are present in the composition of egg yolk. The first two are necessary for the initial stages of embryo formation because they are closest to them and are used earlier. Also, unsaturated fatty acids are precursors of eicosanoids, prostaglandins, prostacyclins, leukotrienes, and other substances. Lipid nutrition affects the metabolic processes in the embryo's body, the intensity of their development, productivity, and resistance of birds **(Orishchuk et al., 2014)**.

Besides, the embryo needs fatty acids to synthesize the phospholipids, which are the components of cell membranes, as well as to synthesize the triglycerides to store energy. There is data that egg yolk lipids contain significantly more linoleic acid than lipids of other tissues. Poultry`s need for polyunsaturated fatty acids (PUFAs) at an early age depends on their use in embryonic

development), which are involved in the regulation of several physiological processes **(Tkach et al., 2018)**.
Almost all lipids are fat-soluble vitamins. More than half of proteins and most parts of the water-soluble egg's vitamins are in the yolk **(Yadgary et al., 2013)**. The yolk influence on the chicken embryo becomes obvious mainly after full use of the protein by the embryo. It is at the end of embryogenesis and starts on the 16-17th day and lasts during the early postpartum period when the chick uses nutrients from the vestigial yolk **(Duh, Vovk and Martsynovskyi, 2017)**.

The need for the chicken embryo in the protein of the yolk varies depending on the level of development of the hatching stage. There are 119 proteins were found in chicken egg yolk. Among them, serum albumin, the breakdown products of vitellogenin (VTG), apovetelenin, immunoglobulin Y (IgY), and ovalbumin have the highest amounts in egg yolk plasma **(Zhu et al., 2020)**.
Therefore, changes in egg composition can significantly affect embryonic development. According to many scholars **(Bhattacharyya et al., 2018; Kermanshahi et al., 2017)**, the full value of eggs primarily depends on the rational bird diet. Restriction in the feeding of laying hens reduces the egg weight and significantly reduces egg production, egg shape index, and content of cholesterol in the yolk **(Li et al., 2019a)**.

Studies **(Li et al., 2019b)** have shown that low food, which laying hens intake, affects the process of embryonic development, changes the expression of myostatin and myogenin genes, and reduces the weight of the offspring at birth. Also, the laying hen's diet affects the amino acids and fatty acids of eggs, which are important nutrients for embryonic development during hatching.
However, significant changes in the ratio of egg components can occur as a result of intensive selection to increase egg production. In highly productive foreign crosses (Lohmann, Highsex, Iza, High Line) the increase in egg mass at the beginning of egg-laying (the first 5 – 6 months) is mainly due to the mass of protein. The percentage of it in the egg reaches 67% **(Orishchuk et al., 2014; Singh, Cheng and Silversides, 2009; Zita, Tůmová and Štolc, 2009)** As a result, the protein-yolk ratio is at the level of 2.5 – 2.7. At the same time, it was found that the most nutritious properties have the eggs with a protein-yolk ratio of 1.9 – 2.0.

Aboriginal poultry (local breeds), which, although less productive, but well adapted to local conditions and is a carrier of a set of valuable features such as resistance to several diseases and adverse environmental conditions, also, has high-quality eggs and meat and is valued socially-cultural life of local communities. In this regard, at the global level, there is a problem to study the quality of bird product of different genetic origin to widely use genotypes which are capable of high egg production and high product quality.

Thus, the purpose of our work was to compare the physical and chemical quality of eggs of different lines and breeds of chickens of domestic and foreign selection.

Scientific hypothesis

This study is based on the hypothesis that genotype is one of the most important factors which influence not only egg-laying and weight, but also the egg quality characteristics. This is especially true in the difference between highly productive foreign crosses (Lohmann, Haysex, Iza, High Line, etc.), which are widely used for egg production, and aboriginal (local) breeds, which are valued in the socio-cultural life of local communities and, although less productive but well adapted to local conditions. Comparative analysis of product quality in poultry of different genetic origin would draw attention to the preservation of the gene pool of local poultry breeds, which are carriers of a set of valuable features such as resistance to several diseases and unfriendly environmental conditions, high-quality eggs, and meat and creation of new selectively significant forms.

MATERIAL AND METHODOLOGY

Samples

The State Poultry Research Station of the National Academy of Agrarian Sciences of Ukraine has been working on the conservation of genetic resources of poultry and its use for many years to create hybrids with high egg production and product quality. Both the autochthonous breeds and populations (Poltava Clay) and the breeds and lines of the Ukrainian selection, (factory line H2) of the Plymouth White breed, Birkivska barvysta) created on their basis, are preserved in the gene pool.

Experimental studies involving poultry were approved and endorsed by the Commission on Bioethics of the State Poultry Research Station NAAS (Ukraine) and conducted following the standards of breeding, keeping, and feeding, as well as the recommendations of the European Convention for the protection of vertebrate animals used for experiments or other scientific purposes.

The aboriginal breed of hens of the egg-meat direction of productivity Poltava clay (line 14) is approved as a new selection achievement by the Order of the Ministry of Agrarian Policy of Ukraine No 781/111 from 6.11.07. The bird is characterized by excellent adaptation to local breeding conditions, increased resistance to neoplastic diseases, high preservation (94.4%) at laying ability 123 – 132 eggs per average laying hen at the age 52 weeks, and egg weight 53.6 – 54.7 g at 30 weeks.

Meat and egg chickens of the factory line H2 of the Plymouth Rock breed approved as a selection achievement by the Order of the Ministry of Agrarian Policy and Food of Ukraine No 146 of April 11, 2016, are better known in Ukraine as Hercules. The bird has a well-defined double type of productivity and high adaptive qualities and are characterized by a high live weight of 3.14 kg (chicks) – 4.1 kg (roosters) and egg weight (65.5 – 68.1 g) at 52 weeks of age at egg-laying per average laying hen 114 – 126 pcs.
Birds of egg production Birkivska barvysta (line A) are of synthetic origin, they were bred based on crossing chickens White Leghorn and roosters of the local population of colored leghorn. The breed is in the final stages of creation, autosexual, sorting accuracy at the age of up to 98%. The bird lays 250 – 265 eggs per year with an average weight of 50 – 51 g at 30 weeks age, 58 – 59 g – at 52 weeks.

These genetic resources are lower in productivity to foreign commercial hybrids, which are represented in the Ukrainian market but are characterized by extremely valuable features, such as high adaptation to local climatic conditions, resistance to several diseases, unpretentiousness to feed, high product quality. That is, local breeds remain

the carriers of valuable hereditary qualities and gene complexes, without which the further breed-forming process would be one-sided.

Animals and Biological Material:

Physico-morphological qualities of eggs of hens of Ukrainian selection - three initial parental forms (H2 - Plymouth White, 14 - Poltava Clay, A - Birkivska barvysta) and two hybrids (H2x14, 14xA) in different age periods (26, 34, 44 weeks of life) were studied. Adult chickens of domestic selection were kept in two-tier group cage batteries at a planting density of 9.5 – 9.8 species per m^2, feeding and keeping conditions of all groups met the standards. The feeding ratio during the egg-laying phase was isoprotein (17% crude protein) and isoenergetic (2650 kcal/kg) and met the norms for hens in terms of basic nutritional values. Dietary ingredients: corn – 49.4%, wheat – 10.0%, sunflower cake – 12.3%, soybean meal – 14.1%, meat and bone meal – 5.0%, bone meal – 1.15%, lysine – 0.08%, methionine – 0.11%, chalk – 7.5%, salt – 0.16%, vitamin premix – 0.2%. A randomized sample of eggs (60 pieces) was evaluated from each experimental group. A total of 900 Ukrainian poultry eggs were evaluated.

At the same time, a comparative analysis of the studied indexes of local poultry with the indexes of imported commercial crosses used in Ukraine (Tetra SL, Tetra H, Super Harko, Lohmann Brown, Haysex White and Brown, High Line) was made. The physical and morphological qualities of eggs from both poultry and final hybrids were studied. Keeping industrial poultry is the group in multilevel cage batteries. Randomized samples of eggs from hens of foreign crosses (60 pieces from each cross) were obtained directly from producers in the. Kharkiv oblast (Ukraine). A total of 720 eggs of the poultry of foreign selection were evaluated.

Laboratory Methods

Freshly laid eggs were examined in the laboratory following such indexes as egg weight (g), shell weight (g), yolk weight (g), albumen weight (g), yolk content, albumen content (%), yolk- albumen ratio, energy value in terms of per 100 g of egg mass (kJ), the content of total lipids in the yolk (%), the fatty acid composition of the yolks (mg/yolk).

Firstly, the eggs were individually weighed with the help of laboratory quadrant scales VLKT-500 (Gosmetr, Russia), after breaking the egg carefully manually separated the yolk from the albumen. Eggshell, including membranes, and yolk were weighed with laboratory quadrant VLKT-500 scales (Gosmetr, Russia). The yolk was carefully rolled out on a paper towel to remove the rest of the albumen before weighing, and the chalazes were carefully removed with tweezers. All masses of egg components were determined within accuracy to 0.1 g.

The mass of the albumen was calculated by subtracting the mass of the shell and yolk from the initial mass of the egg. Using these indicators, the proportion of yolk and protein was calculated as a percentage of total egg weight, and the yolk-albumen ratio was calculated as the ratio of yolk mass to albumen mass.

The energy value was calculated according to the formula (1) offered by Ostryakova and others. **(Ostryakova, Podstreshnyi and Breslavets, 2003)**.

$$E = 100 \cdot (16 \cdot Myo + 2 \cdot Malb) / (Me - Msh) \quad (1)$$

Where:

E is the energy value of eggs (per 100 g of egg mass), kJ; Me, Msh, Myo, Malb – a mass of eggs, shells, yolks, albumen, g; 16 and 2 are constants of energy content in 1 g of yolk and albumen.

Description of the Experiment

The total lipid content in the yolk and assessment of their fatty acid composition was carried out on eggs of domestic chickens (H2 - Plymouth White, 14 – Poltava clay, A – Birkivska barvysta) and foreign cross Tetra SL at the age of 44 weeks. Lipid extraction was carried out by the Soxhlet method. Lipids from 4 g of yolk were extracted with 150 mL of petroleum ether using a Soxhlet extraction device. The extraction had being lasted for 2 hours at a temperature of 150 °C. The fat content was determined by the gravimetric (weight) method: the residue after extraction was dried and weighed.

To determine the fatty acid composition of the yolks there were selected 5 eggs from each group. The yolks were isolated, weighed, and stored at minus 12 °C for subsequent chromatographic analysis according to the method described in **GOST 30418 (1996)** "Vegetable oils. The approach to determining the fatty acid composition". Chromatographic analysis was performed using laboratory gas chromatograph "Crystallux-4000M" with a flame ionization detector and temperature programming, a thermostat for temperatures not lower than 200 °C, with an evaporator for temperatures not lower than 300 °C. Glass gas chromatographic column 2 m long, 2 – 4 mm inner diameter. The following analysis conditions were set on the chromatography: column thermostat temperature – 180 – 190 °C; evaporator temperature – 250 °C; detector oven temperature – 200 °C; carrier gas flow rate – 30 – 40 $cm.min^{-1}$; sample volume – about 1 mm of a solution of methyl esters of acids in hexane.

Statistical Analysis

Calculation of calculated egg quality indexes (albumen weight, albumen. and yolk content, egg-yolk ratio, the energy value of eggs) and statistical processing of the material obtained in the experiment (average values and their standard errors) were carried out with the help of statistical analysis of Microsoft Office spreadsheet Excel. The average values were compared using the Tukey test. The significance level for all tests was $p < 0.01$.

The data of physical and morphological qualities of eggs were analyzed using a two-factor dispersion complex (ANOVA) based on breed and age of chickens, using the general procedure of linear models. The data of egg components were analyzed according to the following model (2):

$$Yijk = \mu + Bi + Aj + (BA)\,ij + eijk \quad (2)$$

Where:

μ is the total average value; Bi – the effect of the I – ïbreed, cross; Aj – the effect of the j`s- age; (BA) ij – the interaction of the i-ï breed, cross with the j`s- age; eijk – accidental error.

RESULTS AND DISCUSSION

The physical and morphological qualities of eggs (egg weight, protein, yolk, and shell) were studied to give the comparative assessment of hybrids, lines and breeds of Ukrainian selection and parental forms and final hybrids of some imported crosses used in Ukraine (Tetra SL, Tetra H, Super Harko, Lohmann Brown, Highsex White and Brown, High Line W36) at different age periods (26, 34 and 44 weeks of life). Several index indicators, based on the obtained data, were calculated: the proportion of albumen and yolk, energy value indicators, and the yolk-albumen ratio.

Most crosses of foreign selection are characterized by high precocity and rapid increase in egg weight, especially in the first months of egg-laying. The birds of local selection, which are mainly a breed of the egg-meat type of productivity, have a lower precocity and slightly lower egg weight **(Rizzi and Chiericato, 2005; Di Rosa et al., 2020; Franco et al., 2020)**.

In our research, the average egg weight of Ukrainian breeds and hybrids was 51.9 g at 26 weeks age and 61.2 g – at 44 weeks, while in foreign crosses it was significantly higher in the respective age periods – 59 g and 64.5 g, respectively.

Parental forms of crosses in the age aspect have been studied taking into account different paces of weight gain of poultry eggs of foreign and local selection, several indicators characterizing the internal qualities of eggs for different breeds, hybrid.

Already at the age of 26 weeks, significant differences (p <0.01) were found between chickens of different origins in such indicators as yolk weight, albumen, and their ratio and energy value of eggs.

Thus, the weight of the yolk in poultry of local and foreign selection at the age of 26 weeks was almost the same and amounted to 14.2 – 14.4 g, although the weight of eggs differed significantly – more than 7.1 g (13.7%). This difference was reflected in the share of yolk, which in local chickens was higher by 4.3% on average and amounted to 28.5% against 24.2% in foreign crosses. In terms of mass and proportion of albumen, the opposite picture was observed. There was a rapid increase in egg mass from the beginning of egg-laying occurred primarily due to an increase in albumen mass in hens of foreign selection. With the same mass of yolk between groups of birds, the mass of albumen in foreign crosses was much higher – by 8 g, as well as its share in the egg – by 5.7%. At this age, there is a significant difference (p <0.01) in the ratio of yolk-albumen – 0.5 in local breeds and hybrids against 0.38 in foreign crosses. Due to the increased yolk content in the egg, the energy value of eggs of the poultry of local selection exceeded the foreign average by an average of 76 kJ (p <0.01).

Similar results were obtained by **Lordelo et al. (2020)**, which at a higher egg weight in a commercial hybrid compared to chickens of some local breeds by 13% recorded a higher proportion of albumen in it by 7.2% and a lower proportion of yolk – by 7.8%.

According to the results of **Danchuk and Trach (2017)**, in highly productive commercial crosses the yolk mass increases with age more than the albumen mass.

In our studies, with the increasing of birds` age, the yolk mass in foreign chicken selection is increased by 17%, in local breeds and hybrids – by almost 30%. At the same time, albumen mass increased by 6% and 22%, respectively. As for the proportion of yolk, for 18 weeks of productivity (from the 26th to the 44th week of the life of the bird) there was a slight increase in this indicator in both local and foreign laying hens - in an average of 1.4-1.6%, but there is a predominance of 4.1% for birds of Ukrainian selection, which eggs are characterized by a large yolk.

At the same time, there is a tendency to a slight decrease in the share of egg albumen with the age of poultry in foreign crosses from 62.8% at 26 weeks to 61 – 61.1% at 34 – 44 weeks. These data are relevant to the results of studies by **Rizzi and Chiericato (2005)**, where it was found a decrease in the proportion of protein from 30 to 42 weeks by 0.9 – 2.7% in chickens cross High Line white and High Line brown.

In chickens of local breeds and hybrids from the 26th to the 34th week of life there was a slight increase in the proportion of albumen (by 1.6%), but then there was a decrease in this figure by 0.6%.

Table 1 The share of influence of various factors on the expression of indicators of morphological qualities of eggs,%.

Factor	Indices				
	ME	MY	PY	RYA	EV
Poultry age	45.5[a]	49.2[a]	5.4	2.7	2.4
Genotype (breed , hybrid)	23.3	13.4	38.7	32.5	35.2
Correlation of age and genotype	8.2	13.5	12.1	12.2	10.9
Random error	23.0	23.9	43.8	52.6	51.5

Notes: [1]ME – egg mass, g; MY – yolk mass, g; PY – the proportion of yolk,%; RYA – the ratio of yolk-albumen; EV – energy value, kJ; a – probably at p <0.01.

Table 2 The number of total lipids in the egg yolk of chickens of domestic and foreign selection.

Index	A	14	H2	TSL (FH)
The amount of total lipids in the yolk, g	5.8 ±0.02[a]	6.0 ±0.03[b]	6.1 ±0.02[b]	5.1 ±0.02[c]
The amount of total lipids in the yolk,% (in dry matter)	61.7 ±0.5[a]	62.0 ±0.5[a]	62.5 ±0.7[a]	57.3 ±0.6[b]
The amount of total lipids in the yolk,% (in natural substance)	31.6 ±0.3[a]	31.9 ±0.3[a]	32.0 ±0.3[a]	29.8 ±0.2[b]

Notes: A – Birkivska barvysta, 14 – Poltava Clay, H2 – Plymouth White, foreign cross Tetra SL (Fnal Hybrid (FH)); a, b – averages with different upper scripts within one age differ significantly in p <0.01.

Table 3 The composition of fatty acids in the yolk of eggs of chickens of domestic and foreign selection, mg/yolk.

Fatty Acid	The amount of fatty acid in the yolk of chicken eggs, mg/yolk			
	A	14	H2	TSL (FH)
Saturated fatty acids				
Miristinova (C14: 0)	17.4 ±0.9	14.6 ±1.0[a]	-	18.9 ±0.8[b]
Palmitinova (C16: 0)	1.288 ±8.4[a]	1.379 ±9.7[c]	1.443 ±8.1[d]	978 ±8.3[b]
Margarinova (C17: 0)	11.6 ±1.2	-	-	12.7 ±1.2
Stearinova (C18: 0)	441 ±3.4[a]	445 ±4.1[a]	462 ±3.8[d]	341 ±4.2[b]
Total	**1.758 ±11.6[a]**	**1.839 ±12.1[c]**	**1.904 ±11.9[d]**	**1.350 ±11.7[b]**
Monounsaturated fatty acids				
Palmitoleic (C16: 1)	157 ±2.4[a]	155 ±3.1[a]	163 ±3.0[d]	132 ±2.6[b]
Heptadecene (C17: 1)	5.8 ±0.4[a]	3.7 ±0.6[c]	-	-
Oleinova (C18: 1)	2.321 ±12.7[a]	1.978 ±12.4[c]	2.240 ±11.9[a]	1,729 ±12.5[b]
Gadolein (C20: 1)	11.6 ±1.2[b]	45.7 ±3.5[c]	207 ±7.4[d]	12.4 ±2.1[b]
Total	**2.495 ±16.4[a]**	**2.182 ±14.7[c]**	**2.610 ±15.4[d]**	**1.873 ±13.9[b]**
Polyunsaturated fatty acids				
Linoleum (C18: 2) n-6	1.143 ±8.2[a]	1.051 ±9.6[c]	846 ±8.5[d]	759 ±8.2[b]
Peanut (C20: 4) n-6	112 ±3.2[a]	206 ±4.1[c]	239 ±4.6[d]	194 ±3.8[b]
Linolenic (C18: 3) n-3	23.2 ±2.7[a]	28.4 ±2.9[a]	41.2 ±3.3[d]	28.4 ±2.8[a]
Total	**1.278 ±12.4[a]**	**1.285 ±13.1[a]**	**1.126 ±12.6[d]**	**0.981 ±12.9[b]**

Note: A – Birkivska barvysta, 14 – Poltava Clay, H2 – Plymouth White, foreign cross Tetra SL (Final Hybrid (FH)); a, b – averages with different upper scripts within one age differ significantly in $p < 0.01$.

Table 4 The composition of fatty acids in the yolk of eggs of domestic and foreign chickens (in% to the total fatty acid content).

Fatty Acid	The amount of fatty acid in the yolk of chicken eggs,% to the total fatty acid content			
	A	14	H2	TSL(FH)
Saturated fatty acids				
Miristinova (C14: 0)	0.31 ±0.02	0.28 ±0.02	-	0.45 ±0.02
Palmitinova (C16: 0)	23.29 ±0.15	25.99 ±0.18	25.58 ±0.14	23.26 ±0.2
Margarinova (C17: 0)	0.21 ±0.02	-	-	0.3 ±0.03
Stearinova (C18: 0)	7.97 ±0.06	8.39 ±0.08	8.18 ±0.07	8.11 ±0.1
Total	**31.78 ±0.21**	**34.66 ±0.23**	**33.76 ±0.21**	**32.12 ±0.28**
Monounsaturated fatty acids				
Palmitoleic (C16: 1)	2.84 ±0.04	2.92 ±0.06	2.89 ±0.05	3.13 ±0.06
Heptadecene (C17: 1)	0.1 ±0.01	0.07 ±0.01	-	-
Oleinova (C18: 1)	41.96 ±0.23	37.27 ±0.23	39.72 ±0.21	41.13 ±0.3
Gadolein (C20: 1)	0.21 ±0.02	0.86 ±0.07	3.67 ±0.13	0.29 ±0.05
Total	**45.11 ±0.82**	**41.12 ±0.28**	**46.28 ±0.27**	**44.55 ±0.33**
Polyunsaturated fatty acids				
Linoleum (C18: 2) n-6	20.67 ±0.15	19.81 ±0.18	15.0 ±0.15	18.05 ±0.2
Peanut (C20: 4) n-6	2.02 ±0.06	3.88 ±0.08	4.23 ±0.08	4.61 ±0.09
Linolenic (C18: 3) n-3	0.42 ±0.05	0.54 ±0.05	0.73 ±0.06	0.67 ±0.07
n-6: n-3	54.02 ±0.31	43.87 ±0.33	26.34 ±0.29	33.82 ±0.31
Total	**23.11 ±0.22**	**24.22 ±0.25**	**19.96 ±0.22**	**23.33 ±0.3**

Note: A – Birkivska barvysta, 14 – Poltava Clay, H2 – Plymouth White, foreign cross Tetra SL (Final Hybrid (FH)).

This difference in the age dependence of the protein content between poultry of local and foreign selection, in our opinion, is explained by the later start of egg-laying in hens of local breeds.

The age-related change in the components of the egg (albumen and yolk) was reflected in its energy value, which directly depends on its content. There was an increase in the energy value of 100 g of egg mass in poultry of local breeds and populations from 665 kJ at the age of 26 weeks to 676.0 kJ at the age of 44 weeks, in foreign birds from 589.0 kJ to 616 kJ, respectively.

According to the results of the evaluation of the influence of various factors on some studied indicators of chicken egg quality (egg weight, yolk weight, yolk content, yolk-albumen ratio, the energy value of eggs), shown in Table 1, the largest and statistically significant contribution to variability of indicators such as weight eggs and yolk weight, had a factor of "bird`s age" 45.5 – 49.2%. The obtained data are also confirmed by the fact that during the experiment (18 weeks) changes in egg weight ranged from 9.3% in foreign birds to 17.9% in local, and by weight of the yolk from 16.9% to 2.1%, respectively.

Table 5 Quality indicators of eggs of breeds, parental flocks and hybrids of poultry of local and foreign selection at different ages (M ± m; n = 60).

Origin	Breed[2]	Indices						
		ME	MY	PY	MA	PA	RYA	EV
26 weeks								
LS	A	49.2 ±0.40	14.2 ±0.13	28.9 ±0.24	28.0 ±0.30	56.8 ±0.36	0.51 ±0.007	672 ±4.1
	14	51.3 ±0.44	14.6 ±0.19	28.6 ±0.33	29.4 ±0.40	57.2 ±0.50	0.50 ±0.009	667 ±5.9
	H2	51.3 ±0.58	14.1 ±0.20	27.5 ±0.29	29.1 ±0.45	56.6 ±0.42	0.49 ±0.008	658 ±5.3
	Hyb1	51.4 ±0.52	14.8 ±0.15	28.8 ±0.28	29.2 ±0.42	56.8 ±0.36	0.51 ±0.008	671 ±5.0
	Hyb2	51.1 ±0.52	14.4 ±0.12	28.2 ±0.26	29.7 ±0.43	58.0 ±0.31	0.49 ±0.007	658 ±5.6
	average	**51.9 ±0.57[a]**	**14.4 ±0.15**	**28.5 ±0.29[b]**	**29.1 ±0.32[a]**	**57.1 ±0.28 [a]**	**0.5 ±0.005[b]**	**665 ±3.4[b]**
FS	HL (PF[4])	58.3 ±0.30	13.1 ±0.10	22.5 ±0.16	37.3 ±0.27	63.9 ±0.22	0.35 ±0.004	565 ±2.8
	TSL(PF)	58.7 ±0.47	14.8 ±0.14	25.2 ±0.20	36.7 ±0.37	62.5 ±0.27	0.40 ±0.005	603 ±3.4
	TH (PF)	59.9 ±0.43	14.8 ±0.13	24.7 ±0.24	37.7 ±0.39	62.8 ±0.28	0.39 ±0.006	595 ±3.9
	SKh(PF)	56.0 ±0.49	13.8 ±0.13	24.7 ±0.20	35.6 ±0.39	63.6 ±0.23	0.39 ±0.004	591 ±3.2
	TSL(FH[4])	62.5 ±0.30	14.0 ±0.16	22.4 ±0.26	40.9 ±0.33	65.4 ±0.34	0.34 ±0.006	557 ±4.4
	HB(FH)	58.1 ±0.47	14.0 ±0.13	24.2 ±0.27	35.9 ±0.45	61.7 ±0.34	0.39 ±0.006	595 ±4.6
	LB (FH)	59.4 ±0.57	15.1 ±0.14	25.4 ±0.12	35.6. ±0.42	60.0 ±0.33	0.42 ±0.004	617 ±4.5
	average	**59.0 ±0.81[b]**	**14.2 ±0.29**	**24.2 ±0.50[a]**	**37.1 ±0.76[b]**	**62.8 ±0.70[b]**	**0.38 ±0.011[a]**	**589 ±8.6[a]**
34 weeks								
LS	A	55.6 ±0.46	16.3 ±0.13	29.4 ±0.25	32.0 ±0.38	57.4 ±0.30	0.51 ±0.007	674 ±4.2
	14	56.3 ±0.55	15.8 ±0.15	28.1 ±0.25	33.6 ±0.45	59.5 ±0.34	0.47 ±0.007	649 ±4.4
	H2	58.4 ±0.50	16.8 ±0.16	28.8 ±0.29	34.3 ±0.44	58.7 ±0.34	0.49 ±0.008	661 ±4.9
	Hyb1	56.3 ±0.56	16.2 ±0.15	29.0 ±0.28	32.3 ±0.47	58.4 ±0.35	0.50 ±0.008	663 ±4.9
	Hyb2	56.1 ±0.61	15.5 ±0.14	27.7 ±0.25	33.5 ±0.50	59.4 ±0.33	0.47 ±0.006	647 ±4.2
	average	**56.5 ±0.53[a]**	**16.1 ±0.25**	**28.6 ±0.34[b]**	**33.1 ±0.48[a]**	**58.7 ±0.43[a]**	**0.49 ±0.009[a]**	**659 ±5.5[a]**
FS	HL (PF[4])	61.5 ±0.27	15.5 ±0.07	25.2 ±0.11	37.9 ±0.23	61.6 ±0.16	0.41 ±0.003	607 ±1.8
	HB (FH)	62.6 ±0.54	16.8 ±0.16	26.8 ±0.27	37.8 ±0.47	60.3 ±0.31	0.45 ±0.007	631 ±4.5
	LB (FH)	59.6 ±0.58	15.0 ±0.12	25.1 ±0,11	36.4 ±0.40	61.1 ±0.15	0.41 ±0.004	594 ±3.9
	average	**61.2 ±1.07[b]**	**15.8 ±0.66**	**25.7 ±0.67[a]**	**37.4 ±0.59[b]**	**61.0 ±0.49[b]**	**0.42 ±0.016[b]**	**611 ±13.3[b]**
44 weeks								
LS	A	60.6 ±0.43	18.2 ±0.15	30.0 ±0.21	34.7 ±0.35	57.2 ±0.26	0.53 ±0.006	682 ±3.6
	14	60.5 ±0.52	17.4 ±0.21	28.7 ±0.29	36.3 ±0.40	59.9 ±0.30	0.48 ±0.007	654 ±4.6
	H2	64.0 ±0.63	19.2 ±0.25	30.0 ±0.34	37.3 ±0.51	58.1 ±0.36	0.52 ±0.009	677 ±5.3
	Hyb1	61.1 ±0.52	19.1 ±0.20	31.4 ±0.27	34.9 ±0.42	57.1 ±0.29	0.53 ±0.015	696 ±4.3
	Hyb2	59.7 ±0.66	17.4 ±0.20	29.3 ±0.32	34.8 ±0.54	58.2 ±0.35	0.51 ±0.009	669 ±5.3
	average	**61.2 ±0.83[a]**	**18.3 ±0.44[b]**	**29.9 ±0.50[b]**	**35.6 ±0.58**	**58.1 ±0.56**	**0.51 ±0.010[b]**	**676 ±7.8[b]**
FS	HL (PF[4])	63.8 ±0.55	17.3 ±0.15	27.1 ±0.24	38.2 ±0.48	59.8 ±0.29	0.46 ±0.006	637 ±4.0
	LB (FH)	65.2 ±0.61	15.8 ±0.12	24.4 ±0.22	40.6 ±0.56	62.3 ±0.37	0.39 ±0.005	594 ±3.9
	average	**64.5 ±0.40[b]**	**16.6 ±0.43[a]**	**25.8 ±0.78[a]**	**39.4 ±0.69[b]**	**61.1 ±0.72[b]**	**0.43 ±0.020[a]**	**616 ±12.4**

Note: [1]LS – local selection, FS – foreign selection;[2]A –Birkivska barvysta, 14 – Poltava Clay, H2 – Plymouth White, Hyb1 – hybrid H2 × 14, Hyb2 – hybrid 14 × A, HL – High Line W36, TSL – Tetra SL, TN – Tetra H, SKh – Super Kharko, HB – Highsex Brown, LB – Lohmann brown;[4]BF – parental Flock; FH – the final hybrid; [3]ME – egg weight, g; MY – yolk mass, g; PY – the proportion of yolk,%; MA –albumen mass, g; PA – the proportion of albumen,%; RYA – the ratio of yolk-albumen; EV – energy value, kJ; a, b – averages with different upper indexes within the same age differ significantly in $p < 0.01$.

At the same time, such a relative indicator as the proportion of yolk is the most (38.7%) influenced by the genetic origin of birds. The same high share influence of genotype on the calculated indicators of the yolk- albumen ratio and energy value is 32.5 and 35.2%, respectively. Also, there was a significant impact of unaccounted random factors on these features, which results in a significant increase in random error (43.8 – 52.6%).

Summing up the results of a comparative study of physical and morphological parameters of eggs of Ukrainian and foreign chickens, we can conclude that the genotype has a significant impact on egg quality.

In all studied periods of the experiment (26, 34, and 44 weeks of the birds` life) there were eggs with higher weight from poultry of foreign selection with an advantage of an average of 5.1 – 12.0% depending on the age of chickens, which significantly affected this indicator. However, even though the eggs of local breeds and hybrids had less weight, they had a higher percentage of yolk – 28.5 – 29.9% against 24.2 – 25.8% in imported crosses. Due to the larger share of yolk in the eggs of hens of Ukrainian selection, their energy value (per 100 g of egg mass) also had an advantage over foreign crosses and amounted to 659.0 – 676.0 kJ against 589.0 – 616.0 kJ. Therefore, eggs from chickens of local breeds, which are valued in the socio-cultural life of local communities, may be more popular among consumers who prefer eggs with large yolks. Besides, the high-quality characteristics of eggs of local breeds and populations are evidence of their value set of genes that require comprehensive study, preservation, and use in the creation of new selectively significant forms.

In the next stage of the study, we studied the total lipid content in the egg yolk of chickens of local selection in comparison with foreign cross Tetra SL (final hybrid (FH)). Higher content of lipids in the egg yolks of domestic chickens was found in comparison with the foreign hybrid Tetra SL (Table 2). Also, the lipid content in eggs of the poultry of egg productivity (line A) is by 0.3 g lower than in eggs of hens of meat-egg productivity (H2).

The study of the fatty acid composition of egg yolks showed that palmitic (C16:0), oleic (C18:1) and linoleic (C18:2) acids have the highest content in yolks: their total amount is more than 80% of the total content (Table 3 and Table 4).

In yolks of eggs of hens of local breeds the general maintenance of saturated and unsaturated fatty acids is higher, than at foreign cross, namely: the maintenance of saturated, monounsaturated, and polyunsaturated fatty acids in eggs of hens of domestic selection was within 1.758 – 1.904, 2.495 – 2.610, 1.126 – 1.278 g/yolk, while in the tested eggs of the final hybrid their content was 1.350, 1.873 and 0.981 g/yolk, respectively. It is necessary to pay attention to the lower content of palmitic acid in eggs of a bird of a foreign cross – 978.0 mg/yolk (Table 3). While in chickens of local breeds this indicator was in the range of 1.288 – 1.443 mg/yolk.

The results of studies by **Bunea et al. (2017)**, **Antova et al. (2019)** and **Mi (2019)**, **Xiao et al. (2020)**, and **Ko et al. (2021)** support our findings. They proved that the main fatty acids in the lipids were oleic (39.1 – 47.3%) and palmitic (26.0 – 35.5%) acids.

Palmitic acid is known to be a factor in hypercholesterolemia, a disease in which blood cholesterol levels rise to abnormal levels. Cholesterol ensures the stability of cell membranes, is involved in the synthesis of vitamins, bile acids, hormones. But with hypercholesterolemia, is deposited on the walls of blood vessels, affects metabolic processes, and leads to the development of serious complications, including heart attack, stroke, hypertension, and others.

Analyzing the content of palmitic acid in TSL eggs as a percentage of the total content of fatty acid in the yolk, we can find the difference in 2.3% and 2.7% compared to eggs H2 and Poltava Clay, respectively, which does not seem significant (Table 4). The total content of saturated fatty acids (SFA) in the eggs of domestic chickens was at the level of 1.758 – 1.904 mg/yolk (31.78 – 34.66% of the total fatty acids), in the eggs of the Tetra SL hybrid – 1.350 mg/yolk (32.12%). As for polyunsaturated fatty acids (PUFA), in the eggs of domestic breeds, their content was determined in the range of 1.126 – 1.285 mg/yolk (19.96 – 24.22%), in the eggs of foreign hybrids – 0.981 mg/yolk %), which indicates a lower nutritional value of the latter (Table 3 and Table 4).

The total content of PUFA n-6 in eggs of chickens of domestic selection in comparison with the foreign cross was estimated. The amount of PUFA n-6 in eggs of local breeds was at the level of 1085.0 – 1255.0 mg/yolk, foreign cross – 953.0 mg/yolk. The content of PUFA n-3 was 1.5 times higher in H2 eggs compared to TSL – 41.2 mg/yolk, which is more than 16% of the minimum daily intake (Table 3).

In percentage of the total fatty acid content in the eggs of the studied breeds of chickens, the largest number are monounsaturated fatty acids, due to the high content of oleic acid in the range of 37.27 – 41.96% (Table 4). The percentage of fatty acids in the eggs of both domestic and foreign birds was almost at the same level. In general, the fatty acid composition of eggs reported in our studies differs slightly from those reported in other studies **(Lordelo et al., 2020; Danchuk and Trach, 2017; Rakonjac et al., 2017; Cherian and Quezada, 2016)**.

CONCLUSION

It was found that the average egg weight of hens of the Ukrainian gene pool (H2, 14, A) and hybrids obtained by crossing them (H2x14, 14xA) was 51.9 g, 56.5 g, and 61.2 g at the age of 26, 34, and 44 weeks, respectively, while in chickens of foreign selection, it was significantly higher in these age periods – 59 g, 61.2 g, and 64.5 g, respectively (p <0.01).

Despite the lower weight of the egg, there is a probable advantage of purebred and hybrid birds of Ukrainian selection over birds of foreign selection in such important components of the internal content of eggs as the proportion of yolk (4.3%, 2.9%, and 4.1% at the age of 26, 34 and 44 weeks, respectively) the yolk-albumen ratio (0.12, 0.07 and 0.08, respectively) and the estimated energy value of eggs (76.0, 48.0 and 60.0 kJ, respectively).

Analysis of variance of the studied quality indicators of eggs showed that the most significant (45.5 – 49.2%) on the weight of the egg and the weight of the yolk is influenced by the age of the bird, and on such calculated indicators as yolk content, yolk-protein ratio, and energy value, significant influence has the genetic origin of poultry (38.7%, 32.5%, and 35.2%, respectively).

It was found that the total lipid content in the egg yolk of domestic chickens is higher by 0.7 – 0.9 g compared to foreign cross Tetra SL (final hybrid). In the egg yolks of domestic chickens, the total content of saturated and unsaturated fatty acids is higher (in the range of 1.758 – 1.904, 2.495 – 2.610, 1.126 – 1.278 g/yolk), while in the studied eggs of foreign cross their content was 1.350, 1.873 and 0.981 g/yolk, respectively. The amount of PUFA n-6 in eggs of local breeds was at the level of 1085 – 1255 mg/yolk, and foreign cross – 953.0 mg/yolk. The content of PUFA n-3 was 1.5 times higher in H2 eggs compared to TSL – 41.2 mg/yolk against 28.4 mg/yolk, which is more than 16% of the minimum daily intake.

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Contact Address:

Lyudmyla Nalyvayko, Luhansk National Agrarian University, Faculty of Veterinary madicine, Department of Infectology, Quality and Safety of Agro-Industrial Complex Products, Slobozhanska Str., 6892703, Starobelsk, Lugans kregion, Ukraine, Tel. +380972995559,
E-mail: vet-doctor@ukr.net
ORCID: https://orcid.org/0000-0002-7485-4127

*Kateryna Rodionova, Odessa State Agrarian University, Faculty of Veterinary madicine, Department of Veterinary Hygiene, Sanitary and Expertise, Panteleimonovskaya Str., 13,65012, Odessa, Ukraine, Tel. 0662486856,
E-mail: katerina.rodionova@ukr.net
ORCID: https://orcid.org/0000-0002-7245-4525

Svitlana Pankova, State Poultry Research Station of National Academy of Agrarian Sciences of Ukraine, Tsentralna Str., 20, 63421, Birky, Zmiiv district, Kharkiv region, Ukraine, Tel.+3809748254936,
E-mail: svet_my@ukr.net
ORCID: https://orcid.org/0000-0001-7504-9878

Natalia Shomina, State Poultry Research Station of National Academy of Agrarian Sciences of Ukraine, Tsentralna Str., 20, 63421, Birky, Zmiiv district, Kharkiv region, Ukraine, Tel.+380982613517,
E-mail: shomina_n@ukr.net
ORCID: https://orcid.org/0000-0001-9658-2559

Oleg Katerynych, State Poultry Research Station of National Academy of Agrarian Sciences of Ukraine, Tsentralna Str., 20, 63421, Birky, Zmiiv district, Kharkiv region, Ukraine, Tel.+380969213974,
E-mail: katerinich@ukr.net
ORCID: https://orcid.org/0000-0003-4865-2238

Mariia Khimych, Odessa state agrarian university, Faculty of Veterinary madicine, Department of Veterinary Hygiene, Sanitary and Expertise, Panteleimonovskaya Str., 13, 65012, Odessa, Ukraine, Tel. +380677992113,
E-mail: khimichms@gmail.com
ORCID: https://orcid.org/0000-0003-2646-3196

Corresponding author: *