

ANALYSIS OF PHYSICAL-MORPHOLOGICAL INDICATORS OF EGGS OF DIFFERENT COLOR IN THE SHAOXING BREED OF DUCKS

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The results of the analysis of physical-morphological indicators of eggs with a shell of different colors of the Shaoxing duck breed are presented in the article. As a result of studies, 1337 eggs, a significant difference was found between the weight indices, the egg shape index, the strength of the shell, the thickness of the shell of the egg ($p < 0,01$) in the eggs of white and green colour. The necessity of further studying the genetic diversity of birds, which causes the individual variability of indices of individual birds, is substantiated

Key words: egg mass, duck, shape index, Shaoxing breed, strength, shell thickness.

Чепіга А. М., Костенко С. О., ¹Король П. В., ²Коновал О. М., ³Лу Л., ³Бу С., ³Хуанг Л., ³Хуанг Ц., ⁴Лі Л. АНАЛІЗ ФІЗИКО-МОРФОЛОГІЧНИХ ПОКАЗНИКІВ ЯЄЦЬ РІЗНОГО КОЛЬОРУ У КАЧОК ПОРОДИ ШАОСІНЬ / Національний університет біоресурсів і природокористування України, 03041, Україна, Київ, вул. Героїв Оборони, 15; ¹Інститут розведення і генетики тварин імені М.В. Зубця Національної академії аграрних наук України, 08321, Київська обл., Бориспольський р-н, с. Чубинське, вул. Погребняка, 1; ²Лабораторія якості і безпеки продукції АПК Національного університету біоресурсів і природокористування України, 03041, Україна, Київ, вул. Героїв Оборони, 15; ³Інститут тваринництва і ветеринарії Чжецзянської Академії сільськогосподарських наук, 310021, Китай, Ханчжоу, Чжецзян, 198, Дорога Шицзяо; ⁴Компанія Чжуцзи Гоувей Полтри Девелопмент, 311813, Китай, Чжунці, Чжецзян, 1, Дорога Хуаньцзогуцзин, Вандзяцзинг. У статті наведено результати аналізу фізико-морфологічних показників яєць зі шкаралупою різного кольору качок породи Шаосін (Shaoxing). У результаті досліджень 1337 яєць встановлено достовірну різницю між показниками маси, індексом форми яйця, міцністю шкаралупи, товщиною оболонки ($p < 0,01$) у яєць білого та зеленого кольору. Обґрунтовано необхідність подальшого вивчення генетичного різноманіття птиці, яке зумовлює індивідуальну мінливість показників окремих особин.

Ключові слова: маса яєць, качка, індекс форми, порода Шаосін, міцність, товщина шкаралупи.

Чепига А. М., Костенко С. А., ¹Король П. В., ²Коновал О. Н., ³Лу Л., ³Бу С., ³Хуанг Л., ³Хуанг Ц., ⁴Ли Л. АНАЛИЗ ФИЗИКО-МОРФОЛОГИЧЕСКИХ ПОКАЗАТЕЛЕЙ ЯИЦ РАЗНОГО ЦВЕТА У УТОК ПОРОДЫ ШАОСИН / Национальный университет биоресурсов и природопользования Украины, 03041, Украина, Киев, ул. Героев Оборони, 15; ¹Институт разведения и генетики животных имени М. В. Зубца Национальной академии аграрных наук Украины, 08321, Киевская обл., Бориспольский р-н, с. Чубинское, ул. Погребняка, 1; ²Лаборатория качества и безопасности продукции АПК Национального университета биоресурсов и природоиспользования Украины, 03041, Украина, Киев, ул. Героев Оборони, 15; ³Институт животноводства и ветеринарии Чжецзянской Академии сельскохозяйственных наук, 310021, Китай, Ханчжоу, Чжецзян, 198, Дорога Шицзяо; ⁴Компания Чжуцзи Гоувей Полтри Девелопмент, 311813, Китай, Вандзяцзинг, Чжецзян, 1, Дорога Хуаньцзогуцзин, Чжунци.

В статье приведены результаты анализа физико-морфологических показателей яиц со скорлупой разного цвета уток породы Шаосин (Shaoxing). В результате исследования 1337 яиц установлена достоверная разница между показателями массы, индексом формы яйца, прочностью скорлупы, толщиной оболочки ($p < 0,01$) у яиц белого и зеленого цвета. Обоснована необходимость дальнейшего изучения генетического разнообразия птицы, которое обуславливает индивидуальную изменчивость показателей отдельных особей.

Ключевые слова: масса яиц, утка, индекс формы, порода Шаосин, прочность, толщина скорлупы.

INTRODUCTION

Egg is a high-value food product. It contains all necessary components for human food as well as biologically active substances in a well-balanced form, which determines its high digestibility (96-98 %) [1]. For this reason, issues related to the breeding of egg ducks and the quality of their eggs, remain relevant for a long time in many countries of the world, and especially in Asia [2, 3]. According to FAO (Food and Agriculture Organization) data for the year 2000, there were about 45 breeds in China, and in Europe in the meantime, there are only 36 [4].

The Shaoxing breed belongs to China's main egg breeds [5]. Ducks of this breed are characterized by high performance. According to the Bureau of Product Quality (Chutki, China), the age of maturity (the beginning of egg laying) in these birds occurs at 130-140 days. The characteristics of the Shaoxing breed include the fact that the peak period of laying eggs lasts from eight to ten months. On average, one duck in 500 days gives from 290 to 310 eggs, which is one of the highest rates for egg breeds [5]. Especially valuable are eggs with a shell of green color. In the ducks of the Shaoxing breed, 70-80 % of the eggs have a white colored shell and only 20-30 % green [5].

The quality of the egg shell plays an important role in the profitability of egg production, since its damage during transportation leads to significant financial losses for the enterprises [6]. The quality of the shell is associated with its strength, thickness, shape [7], as well as color according to the traditions of consumers. Thus, it is known, for example, that consumers in Italy, Portugal, Great Britain and Ireland prefer egg shells of brown color. In Germany, the Netherlands and Spain, people equally buy eggs with a light and dark shell [8]. In Asia, eggs with a colored shell (blue, green, brown) are preferred [3], about 80 %, and in Puerto Rico it reaches almost 100 % [3].

A number of studies indicate that there are differences in the strength of the shell in eggs with a light and dark envelope. According to Tyler and Geake (1958), the eggs with shell of the white color of the Lehorn White Cross had a thicker envelope than the brown-colored eggs of Rhode Island breed, and the eggs from Lehorn Brown Cross (white shell) had the same thickness with brown enveloped eggs of Rhode Island breed [9]. Research by Joseph N. S. and others in 1999, showed, that eggs with a brown color had a greater mass, which is an indicator of shell quality [10]. According to Sekeroglu, the dark color of the shell positively correlates with the strength and thickness of the shell [11].

Subsequent studies Odabasi, Aygun and Hargitai has proven the influence of color on the egg properties of the eggs. These studies have proven that eggs with dark shells have a large mass, shell thickness and strength [12, 13, 14].

However, to date, the correlation between the color and the quality of the egg in general, and in the Shaoxing breed in particular, has not been sufficiently studied. The difference in weight, egg shape index, strength and thickness of eggs of different colors is of particular interest.

The purpose of our study was to determine the correlation between the color of the egg shell and its quality in the ducks of the Shaoxing breed.

MATERIALS AND METHODS

The research was carried out on a duck farm of *Zhejiang Generation Biological Science and Technology Co., Ltd. and in the Poultry Genetics Laboratory of the Zhejiang Academy of Sciences (Zhejiang Province, PRC)*. For the study, 50 ducks of the Shaoxing breed were selected from different poultry houses in which the eggs differed in color of the egg shell (white and green). An individual method of counting the number of eggs dropped by ducks was carried out. The age of experimental females at the beginning of the experiment was 75 weeks (the end of the egg laying) and the experiment lasted 4 months. The mass of eggs, the index of shape and thickness of egg shell (1337 eggs) are determined.

The length (L) and the width (D) of the eggs were measured with an accuracy of 0,1 mm by caliper. Weighing of eggs was carried out on electronic scales JM-A 20001 with an accuracy of 0,1 g.

The egg shape index was calculated using the formula:

$$\text{Egg Shape} = (\text{Egg Width} / \text{Egg Length}) \times 100 [15].$$

Egg shell thickness was measured using ECHOMETER 1061, and the shell strength was checked by means of the Egg Shell Force Gauge Model III machine.

Biometric processing of experimental data was carried out in accordance with generally accepted methods on a PC using MS Excel software.

RESULTS AND DISCUSSION

The table summarizes the results of the experiment to determine the mass, index of shape, thickness and strength of egg shell of different colors in the Shaoxing breed ducks of 75 weeks old. As you know, one of the most important indicators of the food and incubation value of eggs is its mass. It has a direct influence not only on its caloric content, but also on the chemical composition [1]. After analyzing the average weights of eggs with different color shell, we came to the conclusion that eggs with a green shell have a greater mass than eggs with white shell $71,43 \pm 0,208$ and $68,52 \pm 0,415$ g ($p < 0,01$).

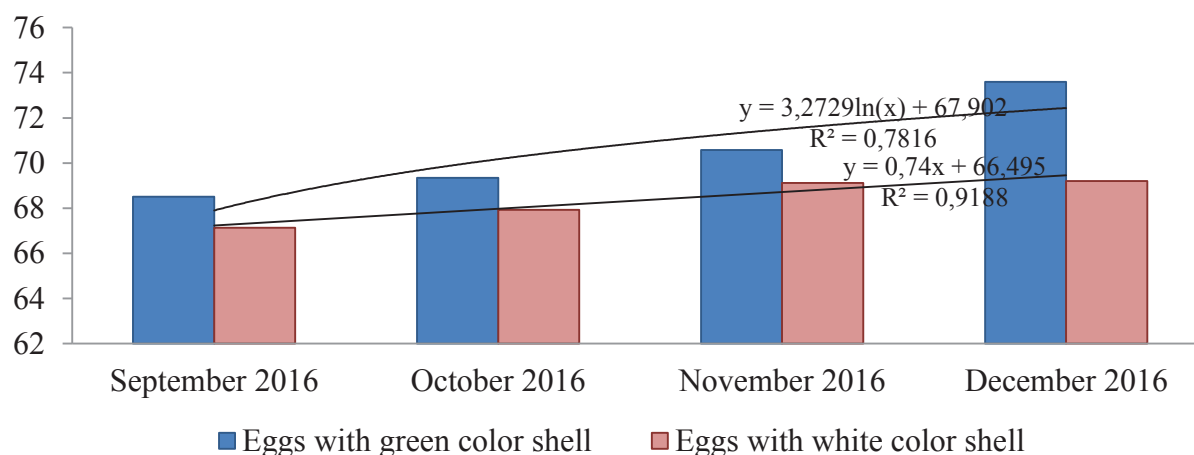


Fig. 1. Change the weight of the egg in Shaoxing breed ducks over time, gr

It is known that the weight and size of the eggs vary during the period of increase in bird's egg laying. So, in the Beijing Duck breed [16] with increasing age, we also observed a change in egg mass. During the 18 weeks of the experiment, it has increased from 91,5 to 94,4 g.

By comparing the weight of eggs with the shell of green and white colour, we found that with age increasing this index increases as well. Particularly interesting was the fact that eggs with a green shell had a greater mass and during the four months of the experiment it increased by 5,08 g, while in eggs with a white shell – by 2,07 g (Fig. 1).

In general, it can be noted that the average weight of eggs from experimental ducks corresponds to the norm, because according to the standard [5], it should reach 62-68 g in the Shaoxing breed, and at the end of the egg laying period it becomes relatively stable (69-73 g).

An important indicator of egg quality is its shape, since it affects the position of the embryo during development [17]. According to the Bureau of Product Quality (Chutki, China), the Shaoxing breed egg shape index should normally be 72–76 % [5].

Table 1 shows the average index of the shape index in eggs of different colors.

Table 1 – Indicators of physical and morphological characteristics of eggs of different colours in the Shaoxing breed ducks

Indicator	Eggs with a shell of green color		Eggs with a shell of white color	
	M ± m	Cv ± m _{Cv}	M ± m	Cv ± m _{Cv}
Egg mass, g	71,43 ± 0,208	9,44 ± 0,206	68,52 ± 0,415*	10,25 ± 0,427
Shape index, %:	75,50 ± 0,117	5,02 ± 0,110	74,79 ± 0,260*	5,90 ± 0,246
- longitudinal diameter, sm	6,04 ± 0,008	4,55 ± 0,099	6,01 ± 0,020	5,70 ± 0,238
- transverse diameter, sm	4,55 ± 0,005	3,78 ± 0,083	4,48 ± 0,010	3,87 ± 0,161
Shell thickness, kg	4,48 ± 0,035	14,80 ± 0,553	3,81 ± 0,064*	14,84 ± 1,188
Shell thickness, mm	0,47 ± 0,006	11,50 ± 0,972	0,43 ± 0,016*	14,05 ± 2,565
- dull end	0,46 ± 0,008	12,85 ± 1,086	0,42 ± 0,016	14,13 ± 2,579
- equatorial part	0,48 ± 0,007	11,31 ± 0,956	0,44 ± 0,019	16,55 ± 3,021
- sharp end	0,46 ± 0,007	13,71 ± 1,159	0,43 ± 0,015	13,18 ± 2,407

Notes: * p < 0,01 in comparison with egg with green color shell.

During the experiment it reached 75,50 ± 0,117 % in eggs with a shell of green color and it reached 74,79 ± 0,260 % (p < 0,01) in eggs with a white color shell.

After analyzing 1337 eggs from the Shaoxing duck breed during the first four months, we found that eggs with a green shell the shape egg index increased by 1,72 (74,92-76,64 %). A slight variation of the egg shape index was observed in a 75-week-old bird with a white shell, its value was 74,1-75,33 % (Fig. 2).

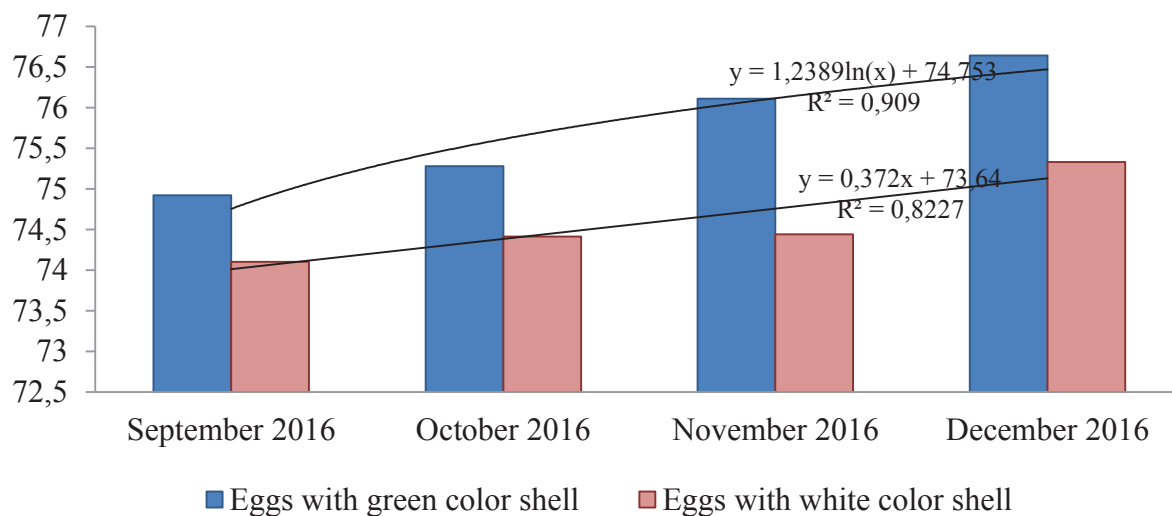


Fig. 2. Change in the egg shape index in the Shaoxing breed over time, %

The tendency to increase the index of egg shape with the age of the bird was also observed in the Beijing duck breed [16]. During the 18 weeks of the experiment, it fluctuated within 65-72 %. The point is that with an increase in the age of the bird, an increase in the egg mass is observed, which affects the change of the shape index.

According to N. Nikolova [6], in chickens with age less than 45 weeks, the egg shape index was 74,4-77,5 %, while in the old bird it was 73,9-76,3 %. This is because the young egg laying bird had a more rounded egg shape, and the bird older than 45 weeks gave eggs of elongated shape, which is a characteristic feature of old chickens.

The Shaoxing breed ducks with age of 75 weeks with a green and white shell, the egg shape index fluctuated within the normal range and corresponded to the standard of breed 72-76 % [13] (table 1).

In studies by M. A. Derkho [1] the egg shape index ranged from 71,5-74,9 %. The increase in the egg mass was accompanied by a decrease in the shape index, that is, the eggs became more elongated, which affected the damage rate of the shell.

Egg shell is a complex and perfect natural packaging, the main purpose of which is to withstand the mechanical effects on the egg, which ensures its integrity. Evaluating the quality of eggs, first of all attention is paid to the strength and thickness of the shell, because the level of damage rate of eggs depends on them; the high level of damage rate leads to a decrease in eggs grade and food safety [18].

In the H & N Brown Nick breed of chickens [12] during the investigation of the thickness of the shell, its positive correlation between the eggs of green and blue ($r = 0,409$) was found. Similar results were obtained by Odabasi [14]. Correlation between the thickness of eggs of green and blue color was 0,41. Negative correlation was observed between the thickness of eggs of white and blue color ($r = -0,92$ and $r = -0,19$).

In white-collared flycatcher [13] the color of eggs (blue-green) was not associated with the thickness of the shell and size. However, the tendency was observed that eggs of larger size had a thicker shell, although the correlation was not significant ($r = 0,36$).

Emilia Hanusova found that the eggs of the Rhode Island Red chickens had a greater thickness than Oravka chicken eggs ($p < 0,01$), but the average egg mass was larger in the Oravka breed [19].

After analyzing the thickness of the shell of eggs of different colors in the Shaoxing breed ducks (table 1), we found that in eggs with a green shell, the average thickness was $0,47 \pm 0,006$ mm, while in white eggs there was $0,43 \pm 0,016$ mm ($p < 0, 01$).

It is discovered that the strength of the shell is a total indicator of many parameters of its quality: thickness, mass, shape of the egg and other characteristics [5]. None of these indicators, taken separately, cannot fully reflect the strength of the shell, directly related to its damage rate. According to Tsyarenko P. P. [18] the strength of the shell practically does not depend on the weight of the egg, but it has the greatest connection with the thickness of the shell of the egg.

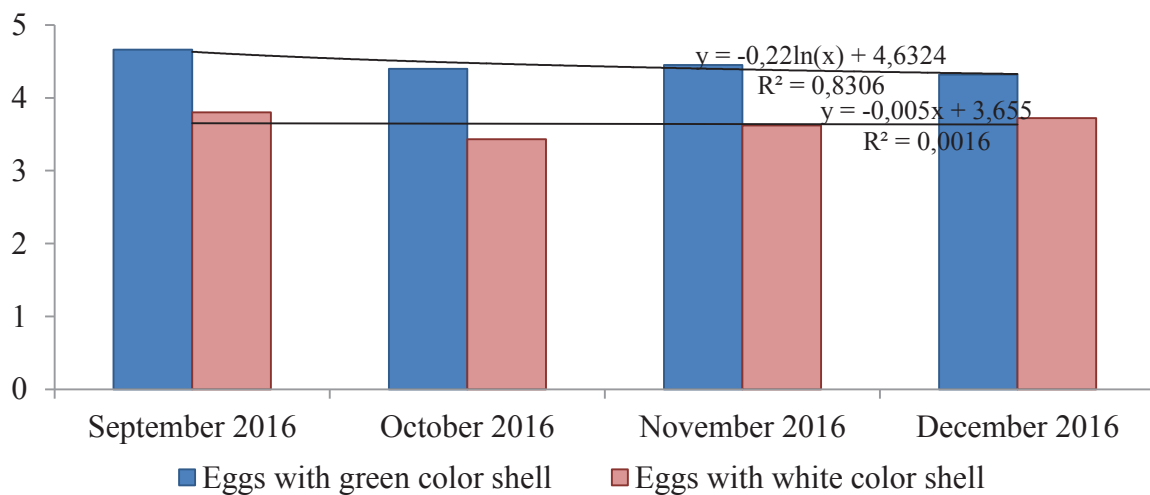


Fig. 3. Changes in egg shell strength in the Shaoxing bread ducks with time, kg

In the Yangzhou [3] chicken the eggs with a light colored shell had a smaller mass than eggs with dark shell color. However, there was no significant correlation between the indicators. The average weight of an egg with a dark shell was 54,32 g, and with light – 50,06 g. According to the researcher [3], the color of the shell is more interconnected with the strength and thickness of the shell.

After analyzing the strength of the egg shell of different colors in the Shaoxing breed (table), we found that in eggs with a green shell, the average strength was $4,48 \pm 0,035$ kg, while white eggs had $3,81 \pm 0,064$ kg ($p < 0,01$). At the beginning of the experiment, the index of strength of the shell of

green color was 4,66 kg, and at the end of the experiment it was 4,30 kg. The strength of the white egg shell fluctuated during the experiment from 3,80 kg to 3,72 kg (Fig. 3).

By comparing the average weight, index, shape, strength, and thickness of the egg shells from the Shaoxing breed ducks with age of 75 weeks (end of the egg laying) for four months, we found that with age the weight and egg shape indexes increase, which is the norm for the ducks of the breed [5]. In contrast, the strength of the egg shell varied from 4,66 to 4,32 kg for green eggs and from 3,80 to 3,72 kg for white eggs, indicating a decrease in this indicator with the age of bird.

Correlation analysis of the physical-morphological indicators of green eggs revealed the relationship between the thickness of the shell and the egg shape index ($r = 0,936 \pm 0,005$), the weight of the egg and its length ($r = 0,681 \pm 0,0164$), weight and width ($r = 0,835 \pm 0,0093$), the width of the egg and the thickness of the shell ($r = 0,6813 \pm 0,02185$). Contrary to this, in eggs with white color of the shell it was found a correlation between the weight and length ($r = 0,703 \pm 0,02298$), mass and width ($r = 0,795 \pm 0,0216$) and the length and shape index ($r = 0,781 \pm 0,0229$). Significant correlation between the shell thickness and its strength was not discovered.

Throughout the experiment, we observed that in eggs with a green shell, the weight, shape index, strength, and thickness of the egg shell were larger than those of white eggs.

CONCLUSION

1. After analyzing of physical-morphological indicators of eggs (the average weight, index, shape, strength, and thickness of the egg shells) from the Shaoxing breed ducks with age of 75 weeks (end of the egg laying) for four months, we found that with age the weight and egg shape indexes increase, which is the norm for the ducks of the breed. In contrast, the strength of the egg shell indicating a decrease in this indicator with the age of bird.
2. According to the analysis of physical-morphological indicators in the Shaoxing breed ducks, it has been reliably found that eggs with a green shell have an average egg mass greater than that of white eggs ($71,43 \pm 0,208$ g and $68,52 \pm 0,415$ g; $p < 0,01$). The shell of eggs with a dark envelope was more durable than in eggs with light shell ($4,48 \pm 0,035$ kg and $3,81 \pm 0,064$ kg; $p < 0,01$). It was determined that the thickness of the shell in green eggs was higher than that of white colored shell eggs ($0,47 \pm 0,006$ mm and $0,43 \pm 0,016$ mm; $p < 0,10$).
3. Subsequent studies are to evaluate ducks of egg breeds taking into account their genotypes, which will give possibility to organize a selection to increase the egg productivity of birds and obtain products with optimal technological properties from them.

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