Estimation of morphological composition and physical traits of hatching eggs in the selected meat hen stocks

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The aim of the experiment was to estimate and compare external and internal traits of hen hatching eggs. One hundred and eighty eggs (60 eggs of each set) originated from three parental stocks of meat hens from reproduction flocks such as Ross 308, Ross PM3 and Flex from Hubbard company were used as an experimental material. The study showed the significant effect of origin on weight and morphological elements of eggs and, at the same time, good usefulness of the tested eggs to the hatching process.

KEY WORDS: meat hens / hatching eggs / morphological traits

In breeding stocks it is not only important to achieve a great number of eggs of good morphological ąuality, but above all to obtain eggs of potentially the best biolo-gical value, which could ensure the proper hatching [18]. The basic biological function of eggs is the ability to develop embryos, which secures species preservation. That is why morphological and functional traits of particular elements of eggs are subordinated to the process [7].

The embryo development and results of hatching depend on both external and internal traits, which are typical of hatching eggs [10, 25], whereas egg weight, its shape and shell quality mostly affect the usefulness and choice of eggs for hatching.

Egg quality traits highly affect hatching results. In many studies [6, 8, 9] it was found that worse hatching results were obtained from too small and too large eggs than from those of an average weight. Moreover, shell quality greatly determined hatching results. Egg shell is of great importance in embryogenesis and, among others, it is a requisite of proper gaseous exchange. Egg shell should be clean, smooth, without roughness, cracks and deformations. Shell quality is determined, in a great part, by its thickness [12, 15, 19, 20], which is conditioned by genetic factors (bird origin), environmental factors, age of laying hens, the length of laying period and feeding [2, 5, 15, 16, 18]. Hatching results depend also on egg freshness and that is the reason why hatching eggs could not be stored longer than 7 days after laying.

Most studies conducted in our country referred to the estimation of egg quality, which originated from laying hens kept in intensive livestock industry. Considerably fewer tests were carried out on hatching eggs, which originated from meat hens of breeding stocks. The aim of the study was to evaluate and compare some selected external and internal traits of eggs in meat hens of Ross PM3, Ross 308 and Flex Hubbard breeding groups.

Material and methods

Hatching eggs, which originated from three parental stocks of 35-week-old meat hens of Ross PM3, Ross 308 and Flex Hubbard breeding groups were used as an experimental material. The birds were kept in the same environmental conditions on litter, according to recommendations. Stocks, which consisted of 6000 to 9000 laying hens, were kept in farms that delivered hatching eggs to Poultry Hatching Plant in Kisielany, which belonged to Drosed SA in Siedlce. All birds were fed all-mashes with the same amount of nutrients as in feeding norms [23]. The studies comprised 60 eggs of each parental group, i.e. 180 birds totally. Egg weight was ranged from 55.0 to 65.0 g. Outer and inner traits of eggs were tested in the study, according to Mroczek methodology [11]. External estimation included egg weight, which was weighed on electronic balance with exact to 0.01 g, as well as egg length and width, which were measured by a slide caliper. The size of air cell was determined by egg candling. The estimation of inner traits was conducted after pouring the egg content on a glass plate and estimating traits as follows:

- weights of shell, outer and inner thin white, thick white and chalaziferous layer of eggs;
- thick white area and thick white height;
- colour, diameter and height of yolk;
- shell thickness in three parts: blunt (I), sharp (II) and middle (III).

Shape index (I_k) and yolk index ($I_ż$) were calculated on the ground of obtained data, according to the formulas:

$$I_k = \text{egg length} : \text{egg width}$$

$$I_ż = \text{yolk height} : \text{yolk diameter}$$

The results were statistically analysed and mean values as well as coefficients of variation were calculated as follows:

$$Y_{ij} = \mu + A_i + e_{ij}$$

where:

Y_{ij} — the trait value,
A_i - effect of *i*-group,
eij - error.

Significance of statistical differences between means was analysed by Tuckey's test [22].

Results and discussion

Table l presented outer traits and the size of air cell of hatching eggs, which originated from meat hens of three parental groups. Egg weight amounted to 57.8-64.4 g. The trait in hens of Ross parental group was similar to those of Flex group and simultaneously significantly larger than in hens of Ross PM3 group. Local studies [3] showed that during the selection of hatching eggs the attention to their weight should be paid. Small chicks are hatched from small eggs, that is, why eggs of weight between 52 and 63 g should be chosen to hatching. In the study, eggs of larger weight were also distinguishable by larger length and width. The calculated shape index amounted to: 1.26 – for eggs, which originated from hens of PM3 group, 1.28 – for hens of Ross 308 group and 1.32 – for hens of Flex group. In hen eggs of proper shape, the index should range from 1.18 to 1.36 [21]. Larger value of shape index was typical of rounded eggs, however, lower value of the trait – of longer eggs. It is commonly believed that better hatchability is shown in round eggs, while in Zglobica and Wężyk [24] studies better hatchability from longer eggs was found. Additionally, Badowski et al. [1] stated positive and significant correlations between body weight of one-day-old goslings and hatching egg weight, the length of short and long axis. However, Calik [4] showed a close relation between body weight and egg weight of laying hens, because body weight of hens decreased together with the decrease in egg weight and inversely – heavier hens generally laid heavier eggs.

The size and location of air cell in eggs testified to egg freshness and at the same time, to their usefulness for hatching. Air cell of eggs immediately after laying amounts to 1.0-1.5 mm of depth and after 6 days from laying 3.0-6.0 mm [17]. In hatching eggs the air cell should have 3-5 mm of depth and should be located in blunt part of eggs. Another location or appearance of so-called moving cells is a trait that disqualifies the eggs from hatching. In the study the size of air cell in the blunt part of eggs, which were laid by hens of Ross PM3, Ross 308 and Flex groups, was similar and on average amounted to approximately 3 mm.

Świerczewska and Siennicka [21] showed that shell thickness of hen eggs amounted to 0.25-0.45 mm and it was not identical on the whole area of eggs. The thickest shell was found in the sharp part of eggs, an average thickness in the blunt part and the thinnest on the short axis. According to Michalak and Mróz [9] shell thickness was genetically determined, however, environmental factors could affect its thickness as well. The opinion was confirmed in other studies [13, 14, 20]. Eggs shell plays an important part in hatching process. Because of its pores, egg shell ensures gaseous exchange between egg content and the environment, as well as it enables an embryo to breathe during the hatching period. In the study shell thickness ranged from 0.27 to 0.35 mm. Eggs from Flex group were characterized by a thinner shell compared to eggs from Ross PM3 (differences statistically proved) and Ross 308 (non-significant differences).

In Table 2 some traits that characterized yolk quality of eggs were shown. Yolk weight remarkably affected the hatching results. Michalak and Mróz [9] stated that eggs from the initial stage of laying had smaller yolks, and worse hatching results from the eggs were proved. In the study yolk weight from Ross PM3 was smaller than that from

Table l - Tabela l
Averages (x) and coefficients of variation ($C_{V\%}$) of external composition characteristics of eggs
Średnie arytmetyczne (x) i współczynniki zmienności ($C_{V\%}$) cech budowy zewnętrznej jaj

Trait Cecha		Parental group Zestawy rodzicielskie		
		Ross PM3	Ross 308	Flex Hubbard
Egg weight (g) Masa jaja (g)	x $C_{V\%}$	57.79^{B} 5.14	64.43^{A} 6.02	64.26^{A} 5.98
Egg length (mm) Długość jaja (mm)	x $C_{V\%}$	55.09^{B} 2.90	57.76^{A} 4.60	58.73^{A} 3.63
Egg width (mm) Szerokość jaja (mm)	x $C_{V\%}$	43.57^{B} 2.27	44.98^{A} 2.16	44.57^{A} 2.23
Shape index Indeks kształtu	x $C_{V\%}$	1.26 0.36	1.28 0.38	1.32 0.44
Size of air celi (mm) Wielkość komory powietrznej (mm)	x $C_{V\%}$	3.5 0.12	3.0 0.16	3.0 0.11
Shell weight (g) Masa skorupy (g)	x $C_{V\%}$	7.01 6.68	7.45 7.70	7.53 7.02
Shell thickness 1 (mm) Grubość skorupy I (mm)	x $C_{V\%}$	0.32 5.87	0.30 9.52	0.28 3.25
Shell thickness II (mm) Grubość skorupy II (mm)	x $C_{V\%}$	0.35^{a} 5.07	0.31 6.68	0.29^{b} 3.03
Shell thickness III (mm) Grubość skorupy III (mm)	x $C_{V\%}$	0.31^{a} 4.98	0,29 6.06	$0,27^{b}$ 3.11

A, B - significant differences between groups at $P \leq 0.01$ - statystycznie istotne różnice między grupami przy $P \leq 0,01$
a, b - significant differences between groups at $P \leq 0.05$ - statystycznie istotne różnice między grupami przy $P \leq 0,05$

Ross 308 and Flex (differences statistically proved). Yolk index of all tested eggs was similar and it did not depend on the hen origin. Eggs from Ross PM3, compared to other groups, had eggs of more intensive colour (differences statistically proved).

White of hatching eggs should be transparent, without foreign substance, spots and turbidity, which could be partly determined by candling. According to Michalak and Mróz [9], the white content in eggs ranged from 60.8 to 67.4%. Worse hatching from eggs of larger white content was found. Moreover, a considerable increase in thick white content makes the hatching process difficult because the egg white is not totally used by growing embryo. Traits that characterized white quality of tested eggs were presented in table 3. Total white weight in eggs amounted to 34.1-37.1 g. The smallest weight in eggs that originated from hens of Ross PM3 group was proved, which undoubtedly resulted from significantly lower egg weigh. Total white weight in hens of Ross 308 and Flex groups was similar (36.8 and 37.5 g). Significantly lower white weight in eggs of Ross PM3 hens (34.3 g) could also result in the smallest thick white area. Thick white area and its height, among others, were an evidence of egg freshness.

Table 2 - Tabela 2
Averages (x) and coefficients of variation ($C_{V\%}$) of yolk quality characteristics of eggs
Średnie arytmetyczne (x) i współczynniki zmienności ($C_{V\%}$) cech charakteryzujących jakość żółtka jaj

Cecha Trait		Parental group Zestaw rodzicielski		
		Ross PM3	Ross 308	Flex Hubbard
Yolk weight	x	16.64^{Bb}	20.16^{A}	19.21^{a}
Masa żółtka	$C_{V\%}$	8.41	9.27	7.57
Yolk index	x	0.50	0.49	0.46
Indeks żółtka	$C_{V\%}$	2.50	2.02	4.10
Yolk colour	x	6.80^{a}	5.88^{b}	5.42^{b}
Barwa żółtka	$C_{V\%}$	12.50	11.03	9.11

A, B - significant differences between groups at P≤0.01 - statystycznie istotne różnice między grupami przy P≤0,01
a, b - significant differences between groups at P≤0.05 - statystycznie istotne różnice między grupami przy P≤0,05

Eggs should be characterized by small thick white area and large white height [17]. Of the tested eggs significantly smaller thick white area and significantly larger white height in eggs of Ross PM3 were found (Tab. 3).

Table 3 - Tabela 3
Averages (x) and coefficients of variation ($C_{V\%}$) of the traits, characterizing the quality of the eggs' white
Średnie arytmetyczne (x) oraz współczynniki zmienności ($C_{V\%}$) cech charakteryzujących jakość białka jaj

Trait Cecha		Parental group Zestaw rodzicielski		
		Ross PM3	Ross 308	Flex Hubbard
Total white weight (g)	x	34.26^{B}	36.78^{A}	37.52^{A}
Masa białka licznie (g)	$C_{V\%}$	9.45	9.27	8.18
outer thin white (g)	x	6.83^{Bb}	8.27^{A}	7.21^{a}
białko rzadkie zewnętrzne (g)	$C_{V\%}$	14.50	7.87	12.71
thick white weight (g)	x	15.80^{B}	15.51^{B}	17.15^{A}
białko gęste (g)	$C_{V\%}$	6.33	14.02	10.22
inner thin white (g)	x	9.73	10.72	10.68
białko rzadkie wewnętrzne (g)	$C_{V\%}$	7.32	6.42	6.53
chalaziferous layer (g)	x	1.90	2.24	2.01
białko chalazotwórcze (g)	$C_{V\%}$	2.66	3.66	2.11
Thick white area (cm^2)	x	61.66^{B}	78.89^{A}	80.43^{A}
Pow. rozlewu białka gęstego (cm^2)	$C_{V\%}$	11.26	10.23	9.75
Thick white height (mm)	x	8.94	8.02	8.17
Wysokość białka gęstego (mm)	$C_{V\%}$	4.19	3.22	4.50

A, B - significant differences between groups at P≤0.01 - statystycznie istotne różnice między grupami przy P≤0,01

a, b - significant differences between groups at P≤0.05 - statystycznie istotne różnice między grupami przy P≤0,05

The contents of morphological elements of eggs were shown in figure 1. Shell content in eggs amounted to from 11.6 (Ross 308) to 12.1% (Ross PM3), yolk content from 28.6 (Ross PM3) to 31.1% (Ross 308), and white content from 57.1 (Ross 308) to 59.3% (Ross PM3). The largest eggs in hens of Ross 308 group were also noticeable by lower shell and white contents as well as larger yolk content compared to other tested eggs.

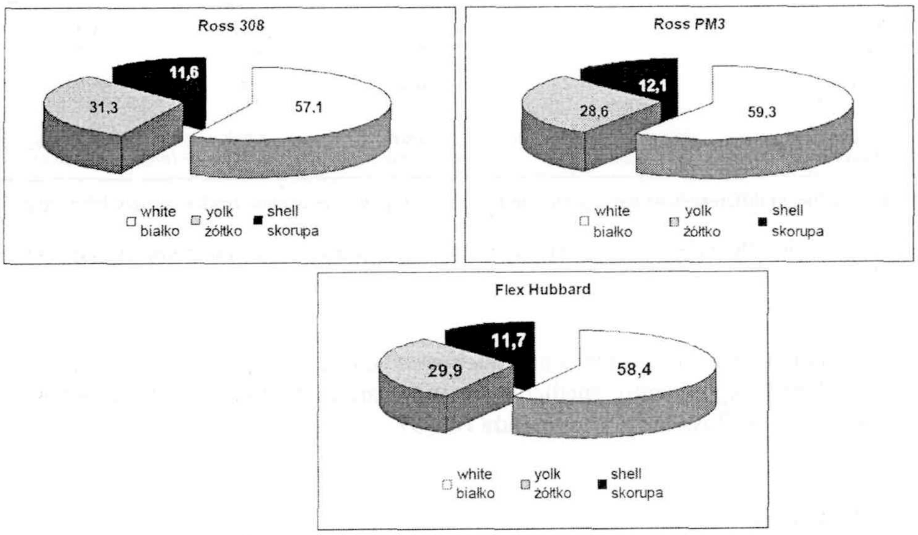

Fig. Content (%) of morphological elements in eggs
Rys. Udział (%) składników morfologicznych w jaju

To sum up, a significant effect of hen origin on egg weight and weight of their morphological elements should be indicated. Eggs in hens of Ross 308 and Flex parental groups were characterized by similar weight, which was statistically larger than egg weight in hens of Ross PM3. At the same time, eggs of larger weight (Ross 308 and Flex) were distinguishable by larger weight of morphological elements, i.e. white, yolk and shell. Eggs that originated from Ross 308 and Flex hens showed slightly smaller white and shell contents, and larger yolk content compared to eggs of Ross PM3. It was stated that eggs of all tested groups were noticeable by proper shape, appropriate freshness and average yolk colour. All eggs were characterized by a good usefulness for hatching in regard to egg weight, shape and morphological content.

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Ocena składu morfologicznego i cech fizycznych jaj wylęgowych wybranych stad kur mięsnych

S t r e s z c z e n i e

Celem przeprowadzonych badań było porównanie cech zewnętrznych i wewnętrznych jaj wylęgowych, pochodzących od trzech stad rodzicielskich kur mięsnych: Ross PM3, Ross 308 i Flex firmy Hubbard. Oceniono po 60 jaj z każdego zestawu rodzicielskiego. Badania wykazały istotny wpływ pochodzenia kur na masę i składniki morfologiczne jaj oraz ich przydatność do lęgu.