The effects of the age and genotype on morphological egg quality of parent stock hens

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SUMMARY
The aim of the present study is to determine the specific genetic traits of morphological features of eggs from breeder hens, combinations between lines from genetic fond populations, at the age of 32 and 50 weeks old. The study was performed with total of 600 hens (by 100 in the combination). The following external and internal morphological parameters of eggs were determined: weight (g) and egg shape index; albumen and yolk weights (g) and albumen and yolk indexes; weight (g) and thickness (mm) of the eggshell; Haugh units; Roche egg yolk color scores.

The morphological analysis of breeder eggs of tested genetic fond populations allowed concluding that:
- in hens at the age of 32 weeks, the weight of eggs did not reach maximum values.
- with age, there was a trend towards higher morphological indices with the exception of eggshell thickness that was found to be slightly decreased.
- the best morphological traits were those of eggs laid down by 32-week-old hens from the combination Labelle × line “C”, and in 50-week-old hens – from the synthetic strain Labelle and the combinations with its participation.
- the selection work with these populations should be directed to increasing of eggs’ weight.

Key words: breeder hens, weight and thickness of the eggshell, Haugh units, Roche egg yolk color scores

INTRODUCTION
The contemporary selection work with poultry of the two types (meat-type and egg-laying) is aimed at increasing their productive and reproductive traits together with reducing the expenses related to their rearing. With regard to breeders’ reproduction, a special attention is paid on the morphological traits of eggs, including the structure and the strength of eggshells, and the quality of albumen and yolk (Bernardo, 1996; Fraser et al., 1998; Fayeye et al., 2005;
These are the primary element whose high quality certifies a viable offspring.

In the breed improvement work it is established that the parents transmit their traits for many generations (Bogdanova et al., 2006). This fact is evidencing that genetic traits are characterized with a high degree of steadiness when passing into next generations.

In genetic fond lines, due to the limited number of birds within a population and their continuous panmixia, the productivity becomes considerably reduced, especially with regard to the egg-laying capacity and the quality of eggs. The maintenance of these lines is expensive, so it is necessary to create combinations of suitable for matching lines with the purpose to obtain a heterosis effect in egg-laying capacity, the weight and morphological composition of eggs (Narushin, 1997; Narushin and Romanov, 2002; Laghi et al., 2005).

The quality of breeder eggs is determined by the affiliation to a given breed or line, the feeding level, the rearing technology, the health status of birds and the terms of eggs storage period (Narushin and Romanov, 2002; Rubolini et al., 2006; Özbey and Esen, 2007).

From the genetic factors, the additive effect of genes is the most important.

The most accurate evaluation of morphological traits is done in birds at the age of 32 and 55 weeks.

The weight of eggs is mainly determined by the breed affiliation, the age, the feeding and rearing technology (Moisseeva, 1972; Vanchev, 1968).

Egg shape is influenced by genetic factors and individual traits, and is determined in the oviduct. The egg shape index ranges between 57 and 92, but it is believed that values under and below 74 are a cause for higher incidence of cracked and broken eggs (Narushin, 2005; Narushin and Romanov, 2002; Narushin et al., 2004).

The weight of albumen is about 56-60% of egg weight. This is an inherited trait, determined by numerous genes (9, 10). The most objective parameter for albumen quality is provided by Haugh units that range between 75 and 80 in breeder eggs.

Yolk weight accounts for about 32% of egg weight and is an important parameter of the normal development of the embryo. It is mainly dependent on the hybrid type and the age, as well as the feeding level (Lacassagne, 1970; Joseph et al., 2000). A primary parameter of yolk quality in breeder eggs is the yolk index that is over 40 (42-47). It increases together with advancing of layer’s age.

The eggshell quality (weight, thickness, structure) is the most essential morphological trait for the normal incubation (Rodriguez-Navarro et al., 2002). The weight of the eggshell is about 12% of egg’s weight, and its thickness is an indirect index of its strength. The normal eggshell thickness in breeder eggs is about 0.30-0.34 mm.
The weight of albumen, yolk and eggshell and the correlations among them have been investigated by a number of authors with regard to utilizing the morphological quality of eggs in the selection work.

The aim of the present study is to determine the specific genetic traits of morphological features of eggs from breeder hens, combinations between lines from genetic fond populations, at the age of 32 and 50 weeks old.

**Material and Methods**

The study was performed in the Poultry breeding section of the Institute of Animal Sciences, Kostinbrod, with total of 600 hens (by 100 in the combination). The external and internal morphological traits of eggs of 32-week-old and 50-week-old breeders from the following lines and line combinations were investigated:

- Combination Red Broiler × White Plymouth rock mini
- Combination line "C" × White Plymouth rock mini
- Synthetic line Labelle
- Combination Red Broiler × Labelle
- Line "D" × White Plymouth rock
- Combination synthetic line Labelle × line "C".

The following external and internal morphological parameters of eggs were determined:

- weight (g) and egg shape index;
- albumen and yolk weights (g ) and albumen and yolk indexes;
- weight (g) and thickness (mm) of the eggshell
- Haugh units
- Roche egg yolk colour scores

Data were statistically processed by Statistical program “Statgrafics”.

**Results and Discussion**

Table 1 presents the data from the morphological study of eggs at the age of 32 weeks old.

The highest weight was that of eggs from the combination Labelle × Line “C” (58.72 g), followed by the combinations Line “C” × White Plymouth rock mini and Red Broiler × White Plymouth rock mini (56.13 g and 55.41 g respectively). The eggs from the other three studied populations were with lower weights: 52–53 g. The variation of the trait was from 5 to 9 % in the different populations. It is interesting to note that the eggs of pure strains Labelle and White Plymouth rock mini were with a weight lower by 3-4 g than that of combinations with their participation. The analysis of data showed that two-line combinations exhibited a heterosis effect with respect to the studied trait. The egg shape index in all groups ranged between 76-78, thus indicating that the shape of eggs was regular and adequate for incubation.
### Table 1. Morphological indexes for breeding eggs from parents of 32 weeks old

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Red broiler x White Plymouth rock mini</th>
<th>Line &quot;C&quot; x White Plymouth rock mini</th>
<th>Labelle</th>
<th>Red broiler x Labelle</th>
<th>White Plymouth rock - normal</th>
<th>Labelle x line &quot;C&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x ± SEM</td>
<td>VC %</td>
<td>X ± SEM</td>
<td>VC %</td>
<td>x ± SEM</td>
<td>VC %</td>
</tr>
<tr>
<td>Weight of eggs, g</td>
<td>56.13±1.23</td>
<td>8.23</td>
<td>55.41±1.46</td>
<td>9.88</td>
<td>52.94±0.94</td>
<td>6.61</td>
</tr>
<tr>
<td>Form index of eggs</td>
<td>77.78±1.36</td>
<td>6.64</td>
<td>77.7±0.63</td>
<td>3.03</td>
<td>76.74±1.00</td>
<td>4.85</td>
</tr>
<tr>
<td>Weight of albumen, g</td>
<td>32.65±0.72</td>
<td>7.25</td>
<td>35.59±0.88</td>
<td>7.98</td>
<td>32.62±0.93</td>
<td>9.11</td>
</tr>
<tr>
<td>Index of albumen</td>
<td>89.73±5.12</td>
<td>21.4</td>
<td>111.2±5.28</td>
<td>17.75</td>
<td>107.15±4.22</td>
<td>14.8</td>
</tr>
<tr>
<td>Weight of yolks, g</td>
<td>17.59±0.6</td>
<td>11.8</td>
<td>14.46±0.81</td>
<td>21.03</td>
<td>14.98±1.08</td>
<td>26.9</td>
</tr>
<tr>
<td>Index of yolks</td>
<td>42.79±0.74</td>
<td>6.49</td>
<td>46.95±0.6</td>
<td>4.95</td>
<td>47.3±1.02</td>
<td>8.03</td>
</tr>
<tr>
<td>Weight of yolk shells, g</td>
<td>5.89±0.18</td>
<td>11.6</td>
<td>5.36±0.14</td>
<td>9.76</td>
<td>5.34±0.11</td>
<td>7.85</td>
</tr>
<tr>
<td>Thick of yolk shell, mm</td>
<td>0.36±0.006</td>
<td>6.06</td>
<td>0.37±0.006</td>
<td>5.63</td>
<td>0.37±0.005</td>
<td>5.07</td>
</tr>
<tr>
<td>Color - Roche</td>
<td>8.47±0.24</td>
<td>10.8</td>
<td>8.2±0.43</td>
<td>19.66</td>
<td>8.8±0.32</td>
<td>13.7</td>
</tr>
</tbody>
</table>

### Table 2. Morphological indexes for breeding eggs from parents of 50 weeks old

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Red broiler x White Plymouth rock mini</th>
<th>Line &quot;C&quot; x White Plymouth rock mini</th>
<th>Labelle</th>
<th>Red broiler x Labelle</th>
<th>White Plymouth rock - normal</th>
<th>Labelle x line &quot;C&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x ± SEM</td>
<td>VC %</td>
<td>X ± SEM</td>
<td>VC %</td>
<td>x ± SEM</td>
<td>VC %</td>
</tr>
<tr>
<td>Weight of eggs, g</td>
<td>63.41±0.96</td>
<td>5.45</td>
<td>60.68±1.95</td>
<td>11.59</td>
<td>63.31±0.95</td>
<td>5.39</td>
</tr>
<tr>
<td>Form index of eggs</td>
<td>75.94±0.79</td>
<td>3.75</td>
<td>76.29±0.52</td>
<td>2.48</td>
<td>74.27±0.87</td>
<td>4.21</td>
</tr>
<tr>
<td>Weight of albumen, g</td>
<td>38.8±0.76</td>
<td>7.07</td>
<td>36.1±1.69</td>
<td>16.9</td>
<td>37.2±0.69</td>
<td>6.69</td>
</tr>
<tr>
<td>Index of albumen</td>
<td>99.72±5.1</td>
<td>18.4</td>
<td>100.5±2.58</td>
<td>9.24</td>
<td>101.9±3.01</td>
<td>10.66</td>
</tr>
<tr>
<td>Weight of yolks, g</td>
<td>18.8±0.65</td>
<td>12.6</td>
<td>18.4±0.44</td>
<td>8.61</td>
<td>20.1±0.45</td>
<td>8.12</td>
</tr>
<tr>
<td>Index of yolks</td>
<td>40.89±0.7</td>
<td>6.2</td>
<td>42.52±0.42</td>
<td>3.55</td>
<td>41.2±0.82</td>
<td>7.16</td>
</tr>
<tr>
<td>Weight of yolk shells, g</td>
<td>5.66±0.14</td>
<td>8.87</td>
<td>6.1±0.18</td>
<td>10.89</td>
<td>5.96±0.15</td>
<td>9.09</td>
</tr>
<tr>
<td>Thick of yolk shell, mm</td>
<td>0.35±0.01</td>
<td>7.71</td>
<td>0.36±0.01</td>
<td>6.32</td>
<td>0.37±0.01</td>
<td>6.56</td>
</tr>
<tr>
<td>Color - Roche</td>
<td>8.36±0.3</td>
<td>13.0</td>
<td>8.36±0.18</td>
<td>7.57</td>
<td>8.57±0.26</td>
<td>10.9</td>
</tr>
</tbody>
</table>
The yolk weight is another essential morphological trait that determined the weight and the vitality of embryos. The highest yolk weight was determined in eggs laid down by hens of groups II, III and VI (17-18 g) i.e. these were combinations when the synthetic population Labelle participated. In the other groups, the parameter had lower values (14-15 g). The variation of the trait within groups was very high.

The intensity of yolk colouration, determined by the Roche scale, was from 8.20 to 8.80. The colour is mainly determined by the pigments in poultry feed, and that is why there were no differences among eggs of the different hen populations.

The albumen weight was within 32-36 g. It was the lowest in eggs of the synthetic population Labelle - 29 g. Haugh units, indicative for albumen consistency, was similar and optimum in all studied eggs and exhibited a low variation. This is an evidence that the albumen was compact and with a good texture.

The weight, the thickness and the structure of the eggshell of breeder eggs were very important factors for the normal course of incubation and the hatching process, as the air exchange during this process is realized through it.

The average weight of the eggshell was 5.5 g. The lightest eggshell had eggs of Labelle birds – 4.8 g. The variation of the parameter among groups was 6 to 10 %.

The eggshell thickness was optimum and almost equal in all groups – 0.365-0.375 mm. The coefficient of variation was low i.e. witnessed a good homogeneity of eggs with regard to this parameter.

The analysis of morphological data of eggs from all tested hen groups at the age of 32 weeks showed that the eggs did not reach the optimum weight for this type of birds.

Table 2 presents the results about morphological traits of eggs laid down by hens at the age of 50 weeks.

The analysis of data showed that with advancing of age of layers, the weight of breeder eggs increased too. It was the highest in the combination line "C" × White Plymouth rock mini and the synthetic strain Labelle – 63 g, i.e. the increased was by 7 and 11 g, respectively. The lightest eggs were those of the combination Red Broiler × White Plymouth rock mini indicating that the eggs of birds from this combination did not change considerably their weight with age. In the other studied combinations, the egg’s weight increased also by 4-5 g. The variation was between 5-10 % for the different groups.

The egg shape index of breeder eggs at the age of 50 weeks was 75-76, i.e. it decreased when hens were older and the eggs’ shape was rounder.

The albumen weight of studied eggs was the highest in line "C" × White Plymouth rock mini – 38.8 g, and the lowest – in Red Broiler × White Plymouth rock mini. In the other combinations and pure lines, albumen weight was about 37 g that is accepted as normal in breeder eggs. The Haugh units,
characterizing the quality of albumen, were similar and normal in all studied eggs as their dimensions were almost equal.

The yolk weight was the highest in the synthetic strain Labelle and the combination where it was the sire line (Labelle × White Plymouth rock mini). This fact allowed us to assume that the population had a dominant effect with regard to the yolk weight and yolk index in breeder eggs. In the other populations, there were no significant differences with regard to these parameters, but a trend towards higher values with advancing of age of layers was observed.

The colour of yolks was almost uniform in all studied genetic fond populations, as the birds received the same compound poultry feed.

The eggshell weight increased in older birds by about 1 g in all studied groups of eggs, with insignificant thinning of the eggshell, i.e. lower thickness, but within the reference range of eggs from this type.

CONCLUSIONS

The morphological analysis of breeder eggs of tested genetic fond populations allowed concluding that:

In hens at the age of 32 weeks, the weight of eggs did not reach maximum values.

With age, there was a trend towards higher morphological indices with the exception of eggshell thickness that was found to be slightly decreased.

The best morphological traits were those of eggs laid down by 32-week-old hens from the combination Labelle × line “C”, and in 50-week-old hens – from the synthetic strain Labelle and the combinations with its participation.

The selection work with these populations should be directed to increasing of eggs’ weight.

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