EVALUATION OF PARTICULAR TRAITS OF PEKIN DUCK BREED STAR 53 OF FRENCH ORIGIN EGGS DURING EGG LAYING

Barbara Biesiada-Drzazga[1], Anna Charuta[2], Dorota Banaszewska[1]

[1]Department of Breeding Methods and Poultry and Small Ruminant Breeding
[2]Vertebrates Morphology Department, Department of Zoology, Institute of Bioengineering and Animal Breeding
University of a Natural Sciences and Humanities in Siedlce
Prusa 14, 08-110 Siedlce, Poland

Corresponding author: Barbara Biesiada-Drzazga
E-mail: barbaradrzazga@wp.pl; Phone: 048 256431268

Abstract. The aim of the research was to evaluate particular internal and external traits of ducks' eggs during laying. The material consisted of eggs from Pekin ducks STAR 53 of French origin. The studied eggs were obtained at the 6th, 12th, 18th and 24th weeks of laying ducks, thus at the 29th, 35th, 41st and 47th weeks of age of these birds. Each research analysis consisted of 20 eggs, so a total of 80 eggs was studied. Particular internal and external traits of eggs were evaluated. The comparison of the results of breeding was conducted for particular ages of layers. The research showed changes in egg size and their lengthening with the increasing egg production. A significant influence of age of ducks on the weight of morphological elements of eggs was not observed. The share of the shell in the whole egg was similar, the share of egg white decreased, whereas the share of egg yolk increased. The thickness of the shell in each of the three studied points decreased with the increase of egg production. The thickest shell was observed in the pointed end, a bit thinner – in the central part and the thinnest at the top of the rounded end of the egg. Out of all 4 fractions, the biggest share of the egg white had the structural white, then the outer thin white, thinner thin white, whereas the lowest share had the chalaziferous layer. The outer thin white and the inner thin white increased with age, whereas the structural white and the chalaziferous layer decreased. Acidity of egg yolks and alkalinity of egg whites grew with the increase of egg production. A constant increase in the egg fertilization from 80.7 to 94.2% and in the percentage of healthy ducklings from hatching (from 76.4 to 87.5%) were observed.

Keywords: duck, eggs, quality.

Introduction

The basic biological function of an egg is its ability to develop an embryo enabling to preserve the species and its all morphological and functional traits are subordinate to it (Horbańczuk and Sales, 2001; Michalak and Mróz, 2003a; Etuk, 2006; Mróz et al., 2007; Lewko and Gornowicz, 2008; Minvielle and Oğuz, 2002; Yuan et al., 2013). According to Zgłobica and Wężyk (1995), Horbańczuk et al. (1999), Calik (2002), Boruta and Kobylińska, (2005) hatching of nestlings depends on external and internal traits of an egg. The choice of eggs to hatching is depenedent on its weight, shape and shell quality. The research showed that there were worse hatching results from too small and too big eggs than from eggs of medium size, irrespective of the poultry species. Moreover, the thickness of the egg shell is also important for the hatching results, as it plays a significant role in embryogenesis of birds. Its thickness is determined by the following factors: genetical (birds' origin), environmental, layer's age, the length of the laying period, food and the health condition (Malec et al., 1999; Michalak and Mróz, 2003a; Barteczko et al., 2004; Mazanowski et al., 2005; Nowak and Sobczak, 2005; Ni et al., 2007; El-Hanoun et al., 2012; Etuk et al., 2012).

The aim of using parental flocks of ducks is to achieve a huge number of hatching eggs guaranteeing a proper development of embryos and then nestlings. Pekin ducks, depending on the date of hatching and environmental conditions during rearing, start laying eggs at the age of 5–6 months and it should last for 8–10 months. During that time, a layer hen can produce up to 160–200 eggs, most of which (140–180) is used for hatching. The percentage of duck egg fertilisation amounts to 85–92%, whereas the hatching from incubation to 70–75%. Thus, from a duck laying approximately 160 eggs a season of hatching eggs it is possible to achieve 120–125 healthy nestlings. Duck eggs are mainly devoted to hatching. An average weight of Pekin duck eggs ranges from 85 to 90g. They have greenish or creamy shell and average shape index at 75.5. The shell constitutes approximately 10%, the white 55% and the egg yolk 35% of the egg weight. Morphological structure and egg quality depends on origin, age and ducks' food as well as environmental conditions (Świerczewska and Siennicka, 2002; Mróz et al., 2003; Michalak and Mróz, 2003b; Zhao et al., 2005; Lewko and Gornowicz, 2008; Rachwał, 2008; Biesiada-Drzazga and Janocha, 2009). The energetic value of a duck egg weighing 85g app. amounts to 185 kcal, including app. 12.8g of protein, 1.14g of ash and 480–680mg of cholesterol. Compared to chicken eggs, duck eggs have a specific scent and consistency. The albumen of the duck egg consists of 14.0–14.5% of dry mass, including 10.5–11.0% of protein at pH 9.0–9.2, whereas the egg yolk has 49.0–50.0% of dry mass with 16.0–16.9% of protein and 27.5–31.0% of fat at pH 6.2–6.5 and 17.0–19.5mg/g of cholesterol (HDL – 4.4–4.6mg/g, LDL – 14.2–15.5mg/g). Most of researches conducted in Poland addressed the quality of eggs derived from domestic origin of Pekin duck (Górski et al., 1998; Kokoszyński et al., 2007; Kokoszyński and Witkowska, 2009). Recently, there has been oserved an ever growing interest in Pekin ducks of French origin (Charuta and Stotko, 2007; Grimaud Freres Selection, 2009, Charuta et al., 2011). Therefore, conducting the research concerning these birds seemed relevant. The aim of the study was to evaluate particular external and internal traits of Pekin duck STAR 53 of French origin eggs during the laying period.

Material and Methods

Flock rearing conditions. The birds were kept in a brick building divided into two even sections populated by 2–3 ducks per 1m^2 of area. Each section contained 420 females and 119 males. The birds were maintained on a deep litter cover with a free access to the range adjacent to the duck house. The room temperature ranged from 8 to 12^{o}C and relative humidity was approx. 70%. Apart from feeding and drinking equipment, the rooms contained the nests.

The breeding conditions and feeding were performed in accordance with ‘Instruction for breeding Pekin ducks’ (Grimaud Freres Selection, 2009). The birds were administered a complete feed ranging from 220g to 300g per 1 bird. The STAR 53 Pekin duck females started laying eggs at 23 weeks of age.

Experimental material. The experiments were performed on eggs collected from 840 Pekin duck females from France, Grimaud Freres Company (STAR 53 H. Y.: ♀GL30 x ♂GL50). The studied eggs were taken at the 6th, 12th, 18th and 24th wk of laying, therefore at the 29th, 35th, 41st and 47th wk of living. 20 eggs were analysed in each period (80 eggs in total). The eggs with no visible signs of injury or no shell disorders were taken for analysis.

Evaluation of egg quality. The methodology described by Mroczek (1997) was used to evaluate: egg weight (g), shell weight (g), white weight (g), outer thin white (g), inner thin white (g), trick white (g), chalaziferous layer (g) and yolk weight (g) by means of a RADWAG WPS 360 C analytical balance (RADWAG, Poland).

Moreover, we analysed such zoometric parameters as: egg length (mm), egg width (mm), Shell thickness in end, mean and pointed egg (μm). The following parameters were evaluated after cracking out the egg content onto a glass plate: trick white area (cm^2), yolk height (mm), yolk diameter (mm). The measurements were made using a LIMIT IP 65 electronic caliper gauge.

The egg shape index was the ratio of maximum egg length to breadth measured using a LIMITIP 65 electronic calliper (LIMIT, Poland). The egg width to length ratio was the egg index (%). Besides, colour, diameter and height of yolk was estimated. The yolk colour was evaluated with a 15-point La Roche scale. A CP-401 pH-meter (ELMETRON, Poland) was applied to determine the pH of yolk and white.

Statistical analysis. The achieved results were analysed statistically, calculating mean values as well as coefficients of variation. Significance of statistical differences between the studied parameters was analysed by Tuckey's test. The hatching results were also calculated for particular laying periods of ducks. The work is based on the results of hatching obtained from the Waterfall Hatchery where records of biological control of hatching have been kept.

Results

It was determined that sizes of eggs changed with increasing egg laying (Table 1). The eggs laid at the beginning, i.e. at the 6th week, were heavier than those laid later, at the 12th week. In further research periods, an increasing tendency in the egg weight was observed from 91.5 to 94.4g. In the analysed periods, when the weight of eggs increased, the measurements along the long and short axis changed as well (length and width of an egg). It was observed that eggs lengthened constantly with laying age (from 68.3 to 71.9mm) and the shape index increased as well (from 1.38 to 1.47) (Table 1).

Table 1. **Mean values and coefficients of variation of egg weights and external traits in particular periods of egg laying**

Trait		Week of laying			
		6	12	18	24
Egg weight (g)	$\bar{x}$ C_v	95.56^a 3.21	91.45^b 4.07	92.63^{ab} 4.09	94.28^{ab} 2.11
Egg length (mm)	$\bar{x}$ C_v	68.33^{ab} 1.63	67.73^a 2.17	69.25^{ab} 2.94	71.89^b 3.02
Egg width (mm)	$\bar{x}$ C_v	49.78^a 5.70	44.13^b 4.03	47.02^{ab} 2.75	49.09^a 2.95
Shape index	$\bar{x}$ C_v	1.38^a 0.03	1.54^b 0.17	1.47^{ab} 0.16	1.47^{ab} 0.02
Shape index (%)	$\bar{x}$ C_v	72.85^a 3.25	65.16^b 3.11	67.90^{ab} 2.03	68.28^{ab} 1.75
Explanatory notes: values marked with small different letters a and b differ significantly at $P \leqslant 0.05$					

Table 2 presents morphological composition of eggs laid by ducks in consecutive weeks of laying eggs. Between weeks 6 and 24, the eggshell weight ranged approximately from 12.58 to 13.77g, the white from

48.76 to 51.07g, and the yolk from 30.11 to 31.29g. In another research (10, 11) in P44 duck eggs weighing 77.8-86.8g, the shell weighed 7.8–8.4g, the white 47.1–49.8g, and the yolk 23.1–28.5g. In our individual study, no significant influence of ducks' age on the weight of morphological components was observed. Ducks at the 6th week of laying (29th week of living) laid eggs of the highest weight and the highest weight of the eggshell, the white and the yolk of all the examined eggs. The above mentioned egg traits differed significantly from traits of eggs laid at the 12th week. Between weeks 12 and 24 of laying, a slight but constant increase in the weight of eggs and weight of particular components was observed. Whereas, the shell share in the egg weight was similar with age. The white share decreased, the yolk share slightly increased.

Table 2. **Mean values and coefficients of variation of morphological components of egg in the studied period of egg laying in ducks**

Trait		Week of laying			
		6	12	18	24
Egg weight (g)	$\bar{x}$	95.56^{a}	91.45^{b}	92.63^{ab}	94.28^{ab}
	C_v	3.21	4.07	4.09	2.11
	%	100.00	100.00	100.00	100.00
Shell weight (g)	$\bar{x}$	13.68	12.58	12.63	13.77
	C_v	1.31	2.01	0.75	0.93
	%	14.32	13.76	13.55	14.61
White weight (g)	$\bar{x}$	51.07^{a}	48.76^{b}	49.10^{ab}	49.22^{ab}
	C_v	4.63	7.01	4.11	7.98
	%	53.44	53.31	53.01	52.21
Yolk weight (g)	$\bar{x}$	30.82	30.11	30.88	31.29
	C_v	2.63	1.98	3.25	4.07
	%	32.25	32.93	33.19	33.34
Explanatory notes: values marked with small different letters a and b differ significantly at $P \leqslant 0.05$					

The thickness of the shell attenuated in the three examined areas with age and with the increasing egg laying (Table 3). Between weeks 6 and 24 of egg laying, the thickness of the shell at the blunt end decreased from 0.608 to 0.420mm, at the sharp end from 0.743 to 0.517mm and in the middle from 0.641 to 0.508mm (the differences were confirmed statistically). In each of the evaluated research terms, the thickest shell was observed at the sharp end of an egg, slightly thinner in the middle and the thinnest at the blunt end of an egg.

Table 3. **Mean values and coefficients of variation of weight and thickness of shell**

Trait		Week of laying			
		6	12	18	24
Shell thickness (μm) in: End egg	$\bar{x}$ C_v	0.608^{a} 0.03	0.510^{ab} 0,02	0.425^{b} 0.11	0.420^{b} 0.28
Mean egg	$\bar{x}$ C_v	0.641 0,13	0.531 0.11	0.521 1.02	0.508 0.06
Pointed egg	$\bar{x}$ C_v	0.743^{Aa} 0.07	0.552^{ABb} 0.02	0.489^{Bb} 0.17	0.517^{ABb} 0.16
Explanatory notes:values marked with small different letters a and b differ significantly at $P \leqslant 0.05$; values marked with capital different letters A and B differ significantly at $P \leqslant 0.01$					

In Table 4, the weight and selected quality traits of the white are shown. Out of the four fractions, the biggest share in the egg white had structural white (45.14–49.53%), then outer thin white (26.27–29.02%), inner thin white (17.53–20.66%). The lowest share had chalaziferous white (5.63–8.71%). With age, the share of outer and inner thin white was observed to increase in the laid eggs, whereas the thick white structural and the chalaziferous white attenuated (the differences were confirmed statistically). Moreover, in consecutive weeks of laying, the thick white area attenuated, which confirmed a better quality of the white and might be the result of attenuation of the share of this fraction in an egg.

No influence of age on the weight and diameter of yolks was observed (Table 5). However, it was found that the height of yolks slightly increased between weeks 6 and 24 of egg laying. According to 15-point La Roche's scale, the yolk colour was at 5.67–6.90. The studied eggs had an average intensity of colour. When the laying increased, acidity of yolks increased from 5.75 at the 6th week to 5.40 at theth 24 week. It should be noted that the weight of yolk influenced the hatching.

Table 4. **Mean values and coefficients of variation of weight and traits of white**

Trait		Week of laying 6	12	18	24
Weight of white (g), Including:	$\overline{X}$	51.07^{a}	48.50^{b}	50.10^{ab}	50.12^{ab}
	C_v	4.63	7.01	4.11	7.98
	%	100.00	100.00	100.00	100.00
Outer thin white	$\overline{X}$	13.67^{ab}	12.74^{a}	14.25^{b}	13.94^{ab}
	C_v	6.23	3.17	2.91	3.14
	%	26.77^{ab}	26.27^{a}	29.02^{b}	28.32^{ab}
Inner thin white	$\overline{X}$	8.95^{ab}	8.12^{a}	9.73^{ab}	11.19^{b}
	C_v	2.11	0.79	2.03	0.68
	%	17.53^{ABa}	17.53^{Aa}	18.01^{ABab}	20.66^{Bb}
Thick white	$\overline{X}$	24.00^{ab}	24.02^{a}	23.17^{ab}	22.22^{b}
	C_v	6.31	4.07	4.44	3.85
	%	47.00^{AB}	49.53^{A}	47.19^{AB}	45.14^{B}
Chalaziferous layer	$\overline{X}$	4.45^{a}	3.24^{ab}	2.95^{b}	2.77^{b}
	C_v	2.16	1.75	0.90	0.11
	%	8.71^{Aa}	6.68^{AB}	6.01^{Bb}	5.63^{Bb}
Thick white area (cm^2)	$\overline{X}$	101.49^{ab}	102.93^{a}	97.03^{ab}	95.32^{b}
	C_v	24.05	7.95	14.25	9.05
pH white	$\overline{X}$	8.10	8.13	8.52	8.47
	C_v	2.11	1.35	2.44	3.75
Explanatory notes: values marked with small different letters a and b differ significantly at P⩽0.05; values marked with capital different letters A and B differ significantly at P⩽0.01					

Table 5. **Mean values and coefficients of variation of weight and traits of yolk**

Trait		Week of laying 6	12	18	24
Weight yolk (g)	$\overline{X}$	30.82	30.11	30.88	31.29
	C_v	2.63	1.98	3.25	4.07
Height yolk (mm)	$\overline{X}$	19.08^{a}	21.30^{ab}	21.90^{b}	21.47^{ab}
	C_v	3.63	2.95	4.11	5.01
Diameter yolk (mm)	$\overline{X}$	51.72	49.42	52.76	49.18
	C_v	4.64	7.02	3.98	4.44
Index yolk	$\overline{X}$	0.37	0.43	0.42	0.44
	C_v	1.75	0.53	2.11	3.04
Yolk colour	$\overline{X}$	5.67^{a}	5.90^{ab}	6.90^{b}	6.05^{ab}
	C_v	1.63	1.75	2.01	2.03
pH yolk	$\overline{X}$	5.75	5.61	5.43	5.40
	C_v	2.11	1.70	2.03	1.75
Explanatory notes: values marked with small different letters a and b differ significantly at P⩽0.05					

Table 6. **Mean values and coefficients of variation of egg hatching**

Trait		Week of laying 6	12	18	24
Egg fertility	(%)	80.70^{Bb}	87.30^{ABa}	92.30^{Aa}	94.20^{Aa}
	C_v	2.90	3.90	5.10	3.10
Hatch of poults from eggs fertilized	(%)	66.30^{Bb}	71.60^{ABa}	79.20^{Aa}	81.20^{Aa}
	C_v	3.40	4.10	2.90	3.20
Hatch of poults from hens	(%)	76.40^{b}	79.80^{ab}	84.20^{a}	87.50^{a}
	C_v	3.20	3.40	4.50	5.10
Explanatory notes: values marked with small different letters a and b differ significantly at P⩽0.05; values marked with capital different letters A and B differ significantly at P⩽0.01					

With the age of ducks, between weeks 6 and 24 of laying (29–42 weeks of living) a constant increase of egg fertilisation was observed from 80.7 to 94.2% (the differences were statistically significant) (Table 6). The increase in the fertilisation resulted in the increase in the percentage of hatching of nestlings from the fertilised eggs (from 66.3 to 81.2%) and in the percentage of healthy nestlings achieved from the hatching (from 76.4 to 87.5%).

Discussion

The changes in the egg size depending on the week of laying observed in the present research was confirmed in other experiments. Statistically significantly higher egg weight in P44 Pekin ducks at the end of egg laying compared to the eggs achieved from the youngest ducks were observed by Kokoszyński et al. (2007) and Kokoszyński and Witkowska (2009). In the research of Kokoszyński et al. (2007), Lewko and Gornowicz (2008), Kokoszyński and Witkowska (2009) the shape index of P44 Pekin duck eggs between 28 and 44 week of ducks' living attenuated from 1.37 to 1.32. In the present work, the egg shape index increased from the 6th to the 12th week of egg-laying; it slightly declined in the 18th week and then remained unchanged until week 24. Both the weight and the shape of eggs are significant in the evaluation of hatching eggs and are the basis for hatching. Badowski et al. (2005) stated positive and highly significant statistical correlations between body weight of one-day-old goslings and hatching egg weight, the length of short and long axis. Calik (2002) showed a close relation between body weight and egg weight of laying hens, because when body weight of hens decreased there was the decrease in egg weight and conversely – heavier hens generally laid heavier eggs. A higher value of shape index was typical of rounded eggs, whereas, lower value resulted in longer eggs. It is believed that better hatchability is achieved from round eggs, although some authors' research (Michalak and Mróz, 2003a) showed higher hatchability from longer eggs. Some authors believe that egg length is a useful trait when one wants to predict hatchability because it affects the egg shape index (Harun et al., 2001). According to Davis et al. (1993), Biesiada-Drzazga and Janocha, (2009), Kokoszyński and Witkowska (2009), Jung et al. (2011), Wistedt et al. (2012) morphological composition of eggs is dependent on birds' origin, food and age. The analysis of egg content conducted by these authors showed that during duck reproduction, the weight and the yolk share in egg increased (from 29.7 to 33.1%), the white share attenuated (from 60.4 to 57.1%) and the shell share remained at a similar level (from 9.7 to 10.0%). The findings in the present work are similar as the weight of duck egg yolk increased in successive weeks of laying period whereas egg white weight declined. Moreover, it was found that during the egg-laying period, egg weight, shell thickness and density, as well as number of pores in the whole shell increased (Adamski et al., 2005). In the researches of Kokoszyński et al. (2007) and Kokoszyński and Witkowska (2009) the thickness of the shell of the P44 reserve flock ranged from 0.38 to 0.39mm, whereas the thickness of the shell of duck eggs from conservative flocks analysed by Michalak and Mróz (2003a) amounted to 0.39–0.42mm. In the present study, egg shells were thicker, regardless of the part of the egg where measurements were taken, because egg shell thickness ranged between 0.42 and 0.74mm. According to Michalak and Mróz (2003c), shell thickness of hen eggs ranged from 0.25 to 0.45mm and it varied on the surface of an egg. The thickest shell was found at the sharp end of eggs, an average thickness at the blunt end and the thinnest on the circumference in the short axis. What is more, the location of pores on the shell was variable. The sharp end was more porous than the blunt end of an egg (Adamski et al., 2005). According to other researchers (Kuźniacka et al., 2004), the thickness of the shell was determined genetically, however environmental factors might and did influence its thickness. The opinion was confirmed by the research by other authors (Malec et al., 1999; Nowak and Sobczak, 2005; Świątkiewicz and Koreleski, 2007; Biesiada-Drzazga and Janocha, 2009) and in the present work. It is worth mentioning that the shell has a very important role in the hatching process. Thanks to its pores, there is a gas exchange between the egg content and external environment and enables the embryo to breathe during incubation. According to Rachwał (2008), eggs should be characterised by a small white area and big height of the white. Similar results were achieved by Książkiewicz and Bednarczyk (1996), whereas Górski et al. (1998) found less intensive colour of yolks. In the opinion of Malec et al. (1999), eggs in the initial period of laying had smaller yolks and the hatching from the eggs was worse, what is confirmed by the results presented in this work. However, other authors (Biesiada-Drzazga and Janocha, 2009) found that hens' origin had influence on the yolk size and their colour, yet no influence of origin on shape index was observed.

Conclusions

The weight of the eggs produced by Pekin ducks from France, Grimaud Freres Company (STAR 53 H. Y.: ♀GL30 x ♂GL50) was found to change along with the development of the egg-laying capacity. Shell thickness at the blunt and pointed ends significantly decreased between the 6th and the 18th and 24th weeks of egg-laying ($P \leq 0.05$). The proportion of inner and outer thin white rose along with the age of the ducks. On the other hand, no similar increase was observed in the case of structural and chalaziferous white. Fertilisation efficacy and the percentage of ducklings hatched from fertilised eggs were found to rise along with duck age.

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