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CHEMICAL COMPOSITION OF TABLE EGGS AS INFLUENCED BY THE ORIGIN OF LAYING HENS

Krystian Dziadek, Ewa Gornowicz, Przemysław Czekalski

National Research Institute of Animal Production, Poultry Research Branch, Zakrzewo n. Poznań

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Chicken eggs produced by nine commercial lines of laying hens: Lohmann Brown, Shaver 579, AK (experimental from IZ-OBD Zakrzewo), ISA White, Messa 445, Messa 443, Astra W-1, Astra W-2, and Astra N were used as experimental material. The layers produced eggs for experiments during the period from 63 to 66 week of age. The effect of bird origin on the basic chemical composition of eggs including certain egg yolk lipids was studied.

Dry matter content in the egg white ranged from 10.98% (Shaver 579) to 13.13% (Astra W-2), whereas in the egg yolk from 54.89% (Lohmann Brown) to 59.64% (Messa 443). Differences in the yolk lipid content between bird groups reached 2.48%, the lowest one (29.37%) was noted in the eggs from AK layers and the highest (31.85%) in the eggs from Astra N birds. Low cholesterol content was found in the eggs from ISA White (13.63 mg/g) and Shaver 579 layers (13.69 mg/g), while high content was determined in the eggs from Astra W1 (14.50 mg/g) and Astra N (14.61 mg/g) layers. Triglyceride content in the egg yolk varied from 199.70 mg/g in Messa 443 group to 236.55 mg/g in Astra N group of birds.

In this study statistically significant differences at $p \leq 0.01$ among nine groups of commercial layers were noted in the chemical composition of the examined table eggs.

INTRODUCTION

The high nutritive value and basic chemical composition of table eggs have been known for a long time [Płotka *et al.*, 1991; Trziszka, 2000]. Many studies have confirmed that the composition of egg content is dependent on both environmental conditions and genetic factors. It has been found that cholesterol content in the egg yolk is heritable and the heritability coefficient is at the level from 0.21 to 0.26 [Cunningham *et al.*, 1974; Anash *et al.*, 1985]. Lenartowicz [1998] compared morphological quality of eggs and content of yolk lipids in eggs of Astra S, Astra W and Messa 245 layer parent stocks and in eggs of Rhode Island Red conservative stock and she found that Messa 245 hens laid the largest eggs of 60.9 g weight. On the other hand, the yolk weight did not differ significantly among groups of layers whereas the lowest yolk weight (13.03 g) was noted in the Astra S layers. Cywa-Benko *et al.* [2000] determined the content of cholesterol and its HDL and LDL fractions in the egg yolk of 64-week-old layers from six conservative strains (H22; Z11; S66; G99; Z33, and R11). They found the highest yolk cholesterol content (14.41 mg/g) in the eggs of layers of the Z33 strain. The authors observed no direct relationship between the egg weight and yolk weight and the correlation coefficients between those traits varied from - 0.1749 to + 0.7974. That finding is of considerable importance to consumers since the quantity of total cholesterol in the egg yolk is directly proportional to its weight. Cholesterol (CH) and triglyceride (TG) content in the eggs from four pure strains of laying hens (P11, WJ44, A22 and K66) was determined by Czekalski *et al.* [2000]. They found that one egg of P11 hen strain contained *ca*. 214 mg of cholesterol whereas that of similar weight laid by WJ44 strain contained as much as 339 mg of cholesterol. The authors also reported significant relationship (from 0.42 to 0.86) between the CH and TG quantity in the egg yolk, however, they noted no relationship between the CH and TG content and yolk weight.

The purpose of this study was to determine the effect of bird origin on the basic composition of table eggs and particular attention was given to the lipids contained in the egg yolk. Table eggs produced by laying hens of various commercial sets used now in Poland were taken as experimental material.

MATERIAL AND METHODS

Laying hens of nine commercial lines namely: Lohmann Brown, Shaver 579, AK (experimental IZ-OBD Zakrzewo), ISA White, Messa 445, Messa 443, Astra W-1, Astra W-2, and Astra N were kept in IZ-OBD Layer Testing Station in Wroniawy. Experimental flocks were maintained in one poultry building on the same compound feeds during rearing and production cycles. The basic composition of diets used in the successive periods of bird life is presented in Table 1.

Table eggs collected from nine experimental flocks of layers of commercial groups specified above were used in the experiments. From each experimental group ninety eggs were taken at random for the chemical analysis, three times

Author's address for correspondence: Krystian Dziadek, Instytut Zootechniki – Oddział Badawczy Drobiarstwa w Zakrzewie k. Poznania, ul. Poznańska 11, 62-069 Palędzie, tel./fax (48 61) 894 12 00, e-mail: ewagornowicz@poczta.onet.pl

TABLE 1. Basic composition of nutrients in the compound feeds for laying hens in the rearing and production periods.

	Unit	DKM-1	DKM-2	DKM-3	DJP	DJ-1	DJ-2
Metabolizable energy	MJ	11.44	11.26	11.26	10.96	10.80	10.46
Crude protein	%	18.90	15.70	15.70	17.40	18.00	17.20
Crude fat	%	3.50	3.00	3.00	3.65	3.40	3.20
Crude fibre	%	3.74	4.00	4.00	3.60	3.65	3.65
Lysine	%	1.06	0.71	0.71	0.83	0.87	0.81
Methonine	%	0.48	0.32	0.32	0.38	0.39	0.38
Methonine + Lysine	%	0.79	0.61	0.61	0.67	0.69	0.66
Calcium	%	1.08	0.91	0.91	1.75	3.60	3.70
Available phosphorus	%	0.53	0.40	0.40	0.37	0.37	0.38
Coccidiostat		+	+	-	-	-	-

thirty eggs at one week intervals. The chemical examination of egg content was carried out between the 63rd and 66th week of bird age. Dry matter content in the egg white and egg yolk whereas fat, cholesterol and triglycerides content in the egg yolk were estimated. The CH content was determined according to Trinder [1969], Siedel *et al.* [1983], Kattermann *et al.* [1984] and of TG according to Trinder [1969]. The photometric measurements and enzymatic reactions were conducted in the "Autolab" biochemical analyser of Boehringer, Mannheim with the use of Boehringer, Mannheim and Randox reagents. On the other hand, the yolk fat content and dry matter content in the egg yolk and white were determined according to the Polish Standard PN-A-86509 "Egg products. Physico-chemical Examination".

The results of the chemical examination of egg were analysed statistically by using the single correlation and analysis of variance.

RESULTS

The content of dry matter in egg white and yolk as well as of fat, triglycerides and cholesterol in the yolk of table eggs laid by hens from various commercial lines is presented in Table 2.

The dry matter content in the egg white was in the range from 10.98 to 11.03% in Shaver 579 and AK groups whereas from 12.30 to 13.13% in Messa 445, Astra W-1, ISA White and Astra W-2 groups of hens. The differences found between those two dry matter values were statistically significant at p≤0.01. The coefficient of variation of that trait noted in the majority of bird groups was similar and ranged from 7.86 to 15.22%. Only in Messa 443 (28.32%), Messa 445 (32.68%) and ISA White (43.16%) a great variation of that trait was observed.

The highest moisture content was determined in the yolk of eggs laid by Lohmann Brown (45.11%) and Astra W-2 (43.12%) hens. Significantly lower moisture level (from 40.36 to 41.67%) was noted in the yolk of eggs from Messa 445, Astra W-1, Messa 443, ISA White, Shaver 579, and AK layers. The yolk moisture content was found to be equalised to a great extent in the eggs of Lohmann Brown hens, the standard deviation attained 0.67% and the coefficient of variation 1.22%.

Taking into consideration the yolk fat content, the eggs from hens of various origin can be divided into two ca-

TABLE 2. Chemical composition of table eggs produced by layers of various commercial lines from 64th until 66th week of age.

Trait	Group								
	Lohmann Brown	Shaver 579	AK	ISA White	Messa 445	Messa 443	Astra W-1	Astra W-2	Astra N
Egg white dry matter									
x,%	11.20	10.98^{B}	11.03 ^{B}	12.65 ^{A}	12.30 ^{A}	11.89	12.60 ^{A}	13.13 ^{A}	11.43
s,%	0.88	1.14	1.35	5.46	4.02	3.37	1.49	1.94	1.74
v,%	7.86	10.38	12.24	43.16	32.68	28.34	11.83	14.78	15.22
Egg yolk dry matter									
x,%	54.89 ^{B}	58.37 ^{A}	58.33 ^{A}	58.46 ^{A}	59.26 ^{A}	59.64 ^{A}	59.32 ^{A}	56.88 ^{B}	57.05
s,%	0.67	3.38	5.29	3.00	3.34	6.88	6.23	13.29	8.11
v,%	1.22	5.79	9.07	5.13	5.64	11.54	10.50	23.36	14.22
Yolk lipids									
x, mg/g of yolk	297.2^{B}	302.9	293.7 ^{B}	312.0 ^{A}	313.2 ^{A}	298.7 ^{B}	315.1 ^{A}	309.0	318.5 ^{A}
s, mg	7.64	3.87	2.68	3.54	2.84	3.51	1.86	4.11	1.89
v,%	25.81	12.77	9.12	11.35	9.07	11.74	5.91	13.30	5.93
Cholesterol									
x, mg/g of yolk	13.91	13.69	14.16	13.63	13.84	14.05	14.50	14.28	14.61
s, mg	2.57	1.56	1.31	1.01	1.48	2.05	1.35	1.52	1.31
v,%	18.4	11.4	9.2	7.4	10.7	14.6	9.3	10.7	8.9
Triglycerides									
x, mg/g of yolk	215.02 ^{B}	215.85 ^{B}	225.22 ^{AB}	227.17 ^{AB}	208.35 ^{BC}	199.70 ^{C}	206.10 ^{BC}	232.95 ^{A}	236.55 ^{A}
s, mg	37.8	27.6	23.9	41.6	32.9	28.7	22.9	44.5	35.0
v,%	17.6	13.9	11.9	17.7	16.1	15.7	12.7	18.1	14.9

A, B – values in the rows with different superscripts are significantly different at p≤0.01

tegories, *i.e.* of lower (29.4 to 29.9%) and higher (31.2 to 31.5%) content. Eggs from AK, Lohmann Brown and Messa 443 hens were in the first while ISA White, Messa 445 and Astra W-2 in the second category. A great variation, *i.e.* v=25.81% of yolk fat content, was observed in eggs from Lohmann Brown layers.

The yolk cholesterol content in the eggs produced by the studied groups of layers demonstrated no significant differences at p≤0.01 among groups of hens and the values varied from 13.63 mg/g (ISA White) to 14.61 mg/g (Astra N).

On the other hand, such differences were noted in the content of yolk triglycerides. The highest values were determined in the eggs of Astra N (236.55 mg/g) and Astra W-2 (232.95 mg/g) hens, while the lowest in Messa 443 hens (199.70 mg/g).

DISCUSSION

Płotka *et al.* [1991], Meennicken [1997] and Trziszka [2000] reported that the dry matter content of egg white has been found at the level of 12.0% on average, and similar results were noted in this study (11.91%). However, in the eggs of two groups of layers (Shaver 579 and AK) examined in this study significantly lower dry matter content was noted which can affect the quality of egg white expressed, among others, by the Haugh number [Trziszka, 2000].

According to Niewiarowicz [1991], the dry matter content of egg yolk can vary from 50.0 to 54.5%. In the present study, the dry matter of yolk was substantially higher and ranged from 54.89 to 59.54%, whereas the average value for eggs of all experimental groups of laying hens was noted at the level of 58.02%. However, the high dry matter content of the egg yolk did not mean similarly high fat content. The average content of fat in the yolk attained 30.68% and confirmed the known data that lipids constitute 32% of yolk weight. Lenartowicz [1998] determined the lowest quantity of yolk lipids (297.59 mg/g) in the eggs of Messa 245 layers, whereas the highest (317 mg/g yolk) in the eggs of Astra S birds. Similar findings on lipid content in the egg yolk of Messa and Astra layers were obtained in this study. Low yolk lipids content (298.7 mg/g) was noted in Messa 443 while the greatest in Astra N (318.5 mg/g) and in Astra W-1 (315.1 mg/g) layers. On the other hand, birds also originating from Messa and Astra breeding stock but different commercial sets demonstrated quite opposite values of that trait. Egg yolks of Messa 445 contained 312.2 mg lipids per gram and those of the experimental Astra AK – 293.7 mg per gram. High cholesterol content (from 14.28 to 14.61 mg/g) was observed in the egg yolk of the following Astra type sets: N; W-1; and W-2. Even higher quantities of yolk cholesterol (15.57 mg/g yolk) in Astra S eggs were reported by Lenartowicz [1998] and Niemiec and Świerczewska [1995]. The content of triglycerides determined in the egg yolk varied greatly and was dependent on bird origin. The majority of the examined groups of layers demonstrated egg yolk triglyceride content from 215.02 to 236.55 mg/g. Similar values from 217.73 to 231.21 mg/g were reported by Lenartowicz [1998] and Trziszka [2000]. On the other hand, in this study, a low content of triglycerides was noted in the egg yolk of Messa 443 (199.70 mg/g), Astra W-1 (206.10 mg/g) and Messa 445 (208.35 mg/g) hens and the differences were statistically significant at p≤0.01.

CONCLUSIONS

In the present study, statistically significant differences at p≤0.01 were noted in the chemical composition of eggs, particularly in the quantities of certain lipid compounds in the yolk of table eggs produced by various commercial lines of laying hens.

The best for the consumer was the chemical composition of Messa 443 eggs. It was characterised by low water content (40.63%) and average water content in white (86.11%) as well as low lipid content in the yolk (298.7 mg per gram) and that of triglycerides (199.7 mg per gram) while average cholesterol level was 14.05 mg per gram.

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WPŁYW POCHODZENIA KUR NIEŚNYCH NA SKŁAD CHEMICZNY JAJ SPOŻYWCZYCH

Krystian Dziadek, Ewa Gornowicz, Przemysław Czekalski

Instytut Zootechniki – Oddział Badawczy Drobiarstwa w Zakrzewie k. Poznania

Materiał doświadczalny stanowiły jaja kur nieśnych pochodzących od 9 zestawów komercyjnych: Lohmann Brown, Shaver 579, AK (eksperymentalna IZ-OBD Zakrzewo), ISA White, Messa 445, Messa 443, Astra W-1, Astra W-2, Astra N. Badania te przeprowadzono w 63-66 tygodniu życia kur. Celem badań było określenie wpływu pochodzenia kur na podstawowy skład chemiczny jaj spożywczych, w tym na zawartość wybranych związków lipidowych w żółtkach.

Zawartość suchej substancji w białkach jaj zawierała się w zakresie od 10,98% (Shaver 579) do 13,13% (Astra W-2), natomiast w żółtkach od 54,89% (Lohmann Brown) do 59,64% (Messa 443). Różnice w ilości tłuszczu w żółtkach wynosiły do 2,48%, którego najmniej stwierdzono w żółtkach jaj kur AK (29, 37%), a najwięcej w żółtkach kur Astra N (31,85%). Spośród ocenianych zestawów kur niską zawartością cholesterolu charakteryzowały się żółtka jaj ISA White 13,63 mg/g oraz Shaver 579 13,69 mg/g, a wysoką Astra W-1 14,50 mg/g i Astra N 14,61 mg/g. Poziom trójglicerydów w żółtkach wynosił od 199,70 mg/g (Messa 443) do 236,55 mg/g (Astra N) (tab. 2).

W przeprowadzonych badaniach stwierdzono statystycznie istotne różnice ($p \leq 0,01$) składu chemicznego jaj spożywczych pochodzących od różnych zestawów komercyjnych kur nieśnych. Najbardziej pożądanym przez konsumenta składem chemicznym cechowały się jaja spożywcze kur Messa 443. Wyrażało się to małą ilością wody w żółtku 40,68% i średnią jej ilością w białku 88,11% oraz niską zawartością w żółtku lipidów 298,7 mg/g oraz trójglicerydów 199,70 mg/g przy średniej zawartości cholesterolu 14,05 mg/g.