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The effect of storage on egg quality and fatty acid content in PUFA-enriched eggs

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ABSTRACT

The study was conducted on 90 thirty-week-old Messa H-43 layers divided into 3 groups. The control group was fed a diet without oil seeds, while the RLP and RLP+E groups were given a diet containing a mixture of 00 rapeseed, linseed, and evening primrose seed. Vitamin E, 200 mg/kg, was added to the RLP+E diet. After 4 weeks, egg quality, fatty acid content, and the lipid oxidation level were determined. Half of the collected eggs were examined the next day and the second half, after 20 days of storage at 12°C. No effect of feeding was found on egg quality. Eggs from groups RLP and RLP+E had less saturated fatty acids and more polyunsaturated fatty acids. Egg weight and albumen quality decreased and yolk content increased during storage, irrespective of the diet. Changes in fatty acid content in yolk during storage were found. Diet and the storage had insignificant effect on oxidation of yolk lipids.

KEY WORDS: rape seed, linseed, evening primrose seed, egg quality, TBA, fatty acids

INTRODUCTION

The subject of many current studies is improving the nutritional value of hen's eggs. One of the methods is increasing egg-yolk polyunsaturated fatty acids (PUFA) content, which can be done by feeding hens diets with oil seeds. Rape 00, linseed and evening primrose seeds can be used for this purpose in Poland. Many authors (Aymond and Van Elswyk, 1995; Brettschneider et al., 1995; Roth-Maier and Kirchgessner, 1995; Niemiec et al., 1997) confirmed the favourable effect of these seeds in diet for layers on PUFA content in egg-yolk. The aim of the presented study was to determine the effect of storage on the quality and fatty acid content of PUFA-enriched eggs.

MATERIAL AND METHODS

The experiment was conducted on a Messa H-43 laying flock. At the age of 30 weeks the flock was divided into 3 groups of 30 hens each. The control group (C) was fed a diet without oil seeds while groups RLP and RLP+E were given the feed with a mixture of rape seed 00, linseed and evening primrose seed. Vitamin E was added to the RLP+E diet (200 mg/kg) as an antioxidant (Table 1). After 4 weeks, two eggs from each hen were collected. Egg weight, Haugh Units (HU) of thick albumen, yolk colour, and yolk content in one of the eggs were determined on the next day, the other egg was evaluated after 20 days of storage at 12°C. The egg quality parameters were measured on an Egg Quality Microprocessor. The crude fat in feed was determined by the Soxhlet method, the method of Washburn and

TABLE 1

Composition of diets, g/kg

Ingredients and analysis		Group		
		Control - C	RLP	RLP+E
Maize		240.0	-	-
Wheat[1]		333.5	410.1	409.9
Evening primose seed		-	28.8	28.8
Lineseed		-	36.6	36.6
Rape seed 00		-	50.0	50.0
Wheat bran[1]		100.0	200.0	200.0
Soyabean meal (47 CP %)		154.0	102.0	102.0
Meat meal		75.0	75.0	75.0
Mineral/vitamin components		97.5	97.5	97.5
Vitamin E		-	-	0.2
Nutritive value				
metabolizable energy, MJ/kg		11.1	11.7	11.7
crude protein, %		18.0	18.0	18.0
crude fat, %		2.7	4.9	4.9
Fatty acids, mg/g diet				
SFA	C 16:0	11.99	8.28	7.80
	C 18:0	4.30	3.30	3.20
MUFA	C 16:1	0.49	0.66	0.67
	C 18:1	12.88	26.70	26.54
PUFA n-6	C 18:2	7.18	12.50	12.15
	C 20:3	1.43	1.41	1.34
	C 20:4	0.14	0.20	0.25
PUFA n-3	C 18:3	0.65	2.35	2.30
	C 22:6	0.01	0.04	0.04

[1] with enzyme

Nix (1974) was used for extraction of yolk fat. In the separation of fatty acids, a Hewlett Packard gas chromatograph HP 6890 (column 25 m, ϕ 320 mm) was used. The level of lipid oxidation in yolk fat in fresh and stored eggs was estimated by the TBA test (Pijanowski, 1984).

RESULTS

No significant differences were found between groups C, RLP, and RLP+E in the weight of fresh or stored eggs (Table 2). After 20 days of storage, egg weight decreased significantly (P<0.01). Fresh eggs differed significantly in thick albu-

TABLE 2

Effect of diet and storage on egg quality parameters

Group	Time of storage days	Egg weight g	Thick albumen quality (HU)	Yolk colour Roche scale	Yolk content in egg, %
C	0	66.88**	90.30^{b**}	11.13	24.23^{a**}
RLP		66.41*	91.72^{b**}	10.97	23.35^{b**}
RLP+E		66.10*	95.80^{a**}	10.63*	23.18^{b**}
SEM		0.693	1.388	0.183	0.276
C	20	64.57	57.22^{B}	10.73	25.99^{a}
RLP		64.93	63.64^{A}	10.73	24.67^{b}
RLP+E		64.29	63.11^{A}	10.27	25.20^{ab}
SEM		0.744	1.594	0.201	0.336

^{a,b,A,B} values in columns within time of storage with different superscripts differ significantly: capitals at P< 0.01; small letters at P< 0.05

** time of storage effect within group significant at: * P<0.05; ** P<0.01; SEM - standard error of the mean

men quality. During storage, albumen quality significantly (P<0.01) decreased in each group. Egg yolk colour of fresh and stored eggs was about 11 points on the Roche scale in all groups. The percentage of yolk in fresh egg was significantly higher in group C than in groups RLP and RLP+E. Yolk content increased by about 1.5% during storage. Feeding hens diets containing oil seeds had a significant effect on fatty acid content in yolk of fresh eggs (Table 3). Eggs from groups RLP and RLP+E had less C 16:0 and C 18:0 SFA and more C 18:3 and C 18:2 PUFA in comparison with the control group. The greatest changes after 20 days storage were found in the content of MUFA and PUFA n-3. The diet and the storage had no significant effect on TBA extinction, vitamin E added into the diet tended to reduce fat oxidation in yolk (Table 3).

TABLE 3

Effect of diet and storage on fatty acid content in egg yolk, mg/g yolk

Group	Time of storage days	TBA	SFA		MUFA		PUFA n-3		PUFA n-6			Ratio
			C 16:0	C 18:0	C 16:1	C18:1	C18:3	C 22:6	C 18:2	C 20:3	C 20:4	n-6/n-3
C	0	0.616	47.18^{A*}	21.16^{A}	13.86^{A}	114.47^{B**}	4.21^{B**}	2.62^{B}	21.34^{B}	0.45^{A}	2.97	3.63
RLP		0.647	41.59^{B}	19.53^{B}	10.02^{B**}	153.23^{A**}	4.74^{A}	6.07^{A*}	21.66^{B}	0.40^{B}	2.91^{**}	2.31
RLP+E		0.613	40.40^{B*}	18.63^{B**}	9.51^{B}	160.06^{A**}	4.73^{A*}	5.81^{A**}	24.08^{A}	0.37^{C**}	2.89	2.59
SEM		0.018	0.911	0.405	0.288	3.597	0.096	0.125	0.514	0.010	0.067	
C	20	0.652	44.15	20.51	14.46^{a}	126.67^{B}	4.77^{B}	2.73^{C}	22.46^{B}	0.43	2.86^{A}	3.43
RLP		0.680	42.15	20.28	12.37^{b}	114.72^{C}	4.52^{C}	4.63^{B}	20.22^{C}	0.41	2.62^{B}	2.54
RLP+E		0.664	43.31	20.66	11.54^{b}	138.03^{A}	5.03^{A}	6.32^{A}	24.88^{A}	0.41	3.01^{A}	2.49
SEM		0.025	0.885	0.479	0.693	2.721	0.086	0.207	0.582	0.011	0.076	

^{a,b,A,B} as in Table 2

DISCUSSION

The presented results are similar to those reported by other authors who demonstrated that oil seeds added to laying hen diets significantly increased the PUFA content in egg yolk (Aymond and Van Elswyk, 1995; Brettschneider at al., 1995; Roth-Maier and Kirchgessner, 1995; Niemiec at al., 1997). A higher content of C 18:2 and C 22:6 fatty acids may be obtained by increasing the linseed content in the diet to 25%, however, this treatment can have a negative effect on egg smell and taste (Aymond and Van Elswyk, 1995). Egg quality and yolk fatty acid contents change during storage. Płotka and Sroczyński (1984) showed a decrease in the MUFA and PUFA contents in frozen yolks as compared with fresh eggs. Gebert at al. (1998) also found that addition of vitamin E to the diet for laying hens reduced fat oxidation in yolk.

CONCLUSIONS

Rape 00, linseed, and evening primrose seeds can be used in laying hen diets to increase the egg-yolk PUFA contents without negatively affecting egg quality.

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STRESZCZENIE

Wpływ przechowywania na jakość jaj i skład kwasów tłuszczowych w jajach wzbogaconych w wielonienasycone kwasy tłuszczowe (PUFA)

Badania wykonano na 90 nioskach Messa H-34, podzielonych na 3 grupy, w wieku 30 tygodni. Grupę kontrolna (C) żywiono paszą bez udziału nasion roślin oleistych, grupę RLP i RLP+E żywiono paszą zawierającą nasiona rzepaku 00, lnu i wiesiołka. Do paszy w grupie RLP+E dodano witaminę E w ilości 200 mg/kg. Po czterech tygodniach wykonano ocenę jakości jaj, określono zawartość kwasów tłuszczowych w żółtku i test TBA. Połowę jaj oceniano następnego dnia po zniesieniu, pozostałe jaja po 20 dniach przechowywania w temperaturze 12°C. Nie stwierdzono wpływu żywienia na jakość jaj. Jaja z grup RLP i RLP+E miały niższą zawartość SFA i wyższą PUFA w porównaniu z grupą C. Masa jaja i jakość białka obniżała się, a zawartość żółtka w jaju zwiększała się w czasie przechowywania, niezależnie od sposobu żywienia kur. Stwierdzono zmiany w zawartości kwasów tłuszczowych w żółtku w czasie przechowywania. Żywienie i przechowywanie miało nieistotny wpływ na proces oksydacji lipidów żółtka.