INFLUENCE OF GRADED LEVELS OF RAPE SEED IN THE DIETS OF COMMERCIAL BROWN LAYERS ON EGG QUALITY

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Summary. The experiment was performed on eggs laid by Lohmann Brown laying hens fed diets without rape seed (I) or with 7.5 % (II), 15.0 % (III), 22.5 % (IV) and 30.0 % (V) of chemical and hydro-thermal treated rape seed. From 27th to 62nd weeks of age, at four-week intervals, 36 eggs were selected randomly to determine the concentrations of fatty acids in the yolk. An increase in the levels of both rape seed and rape seed oil in the experimental diets resulted in an increase in the content of n-6 and n-3 fatty acids, as well as in the narrowing of the n-6 : n-3 ratio.

Key words: laying hens, rape seed, egg quality, fatty acid profile, n-3 fatty acids

KIAUŠINIŲ RUDU LUKŠTU KOKYBĖ LESINANT VIŠTAS LESALAIS SU SKIRTINGU RAPSŲ SĖKLŲ KIEKIU

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Santrauka. Eksperimento metu buvo tiriama Lohmann Brown vištų dėslumas. Vištos lesintos lesalais, kurių sudėtyje nebuvo rapsų sėklų (I grupė) arba įmaišyta 7,5 (II grupė), 15,0 (IV grupė) ir 30 proc. (V grupė) chemiškai bei hidrotermiškai apdorotų rapsų sėklų. Nuo 27 iki 62 vištų amžiaus savaitės kas 4 savaites buvo atrenkami 36 kiaušiniai riebalų rūgščių koncentracijai nustatyti trynyje. Didėjant rapsų sėklų ir rapsų aliejaus kiekiui lesaluose, didėjant n–6 ir n–3 riebalų rūgščių kiekiui, mažėja n–6 ir n–3 santykis.

Raktažodžiai: vištos dedeklės, rapsų sėklos, kiaušinių kokybė, riebalų rūgščių sudėtis, n–3 riebalų rūgštys.

Introduction. Egg yolk fatty acids belong to the group of hen egg nutrients whose concentrations can be modified by the diet (Ternes et al., 1994). The n-3 fatty acids play a particularly important role in human nutrition (D-A-CH, 2005). Eggs can be enriched with these acids by adding fish oil, seaweed extract or linseed oil – characterized by high levels of n-3 fatty acids - to diets for laying hens (Nollet, 2001). Rape seed oil obtained from double-low varieties is also relatively rich in n-3 fatty acids, especially in alpha-linolenic acid (Jahreis, 2000). The aim of the study was to estimate the suitability of full-fat rape seed as components of diets for brown-egg laying hens (Brettschneider, 2006) as well as to determine whether varied levels of rape seed oil intake affect the fatty acid profile in the egg yolk fat.

Materials and methods. Lohmann Brown laying hens were fed crude and processed rape seed of the double-low variety "LIRAJET". The content of crude or processed rape seed in the diets for laying hens was as follows: 0 (group I), 7.5 (group II), 15.0 (group III), 22.5 (group IV) and 30.0% (group V). Apart from rape seed, the ration contained wheat, soybean oil, wheat bran, calcium carbonate, calcium phosphate and a mineral-vitamin premix. The levels of apparent metabolizable energy and nutrients (except for crude fat and fatty acids) were the same in all diets. The varied amounts of rape seed added to the ration enabled to increase the concentrations of linoleic acid, linolenic acid and alpha–linolenic acid, as compared with the low-fat diet for the control group (table 1). The linoleic acid to alpha-linolenic acid ratio changed as well.

Table 1. **Fatty acids contents[1)] (g/kg) of the feed mixture (90% dry matter)**

Fatty acid	Groups				
	I (0[2)])	II (7.5)	III (15.0)	IV (22.5)	V (3 0.0)
palmitic acid (C 16:0)	3.8	5.1	8.0	8.0	9.2
stearic acid (C 18:0)	0.46	0.96	1.32	1.91	2.41
oleic acid (C 18:1)	2.2	21.8	40.7	56.9	74.4
linoleic acid (C 18:2 n-6)	8.0	15.7	21.2	28.3	33.2
alpha-linolenic acid (C 18:3 n-3)	0.46	3.4	7.0	9.7	12.7
ratio of n-6 to n-3 fatty acid	17.4	4.6	3.0	2.9	2.6

[1)] main fatty acids; [2)] rape seed in % of the feed mixtures

All experimental groups included eight replications, each of nine hens (a total of 72 laying hens per group). The birds were kept in single cages. The experiment lasted for 36 weeks (27th to 62nd weeks of age). From the beginning of the experiment, at four-week intervals (nine times), nine eggs were selected randomly of four replications to analyse the fatty acid profile. Following weighing (the whole egg and the yolk), the yolks of these eggs were combined into collective samples (four collective samples per date and per group, i.e. a total of 36 samples per group). 100 g samples taken of each collective sample were dried and frozen. The levels of crude fat and fatty acids were determined in these samples as well as in rape seed and diets (Brettschneider, 2006).

Results and discussion. An increase in the rape seed content of the experimental diets was followed by an increase in the intake of linoleic acid, linolenic acid and alpha–linolenic acid (table 2).

Table 2. **Feed intake and consumption of oleic acid (C 18:1), linoleic acid (C 18:2) and alpha-linolenic acid (C 18:3) (average value 27th to 62nd week)**

Group	Feed intake [2]	Consumption (mg/hen/day) [3]		
	g/hen/day	C 18:1	C 18:2	C 18:3
I (0[1])	117 ± 9	257	936	54
II (7.5)	115 ± 8	2507	1806	391
III (15.0)	115 ± 7	4680	2438	805
IV (22.5)	119 ± 7	6771	3368	1154
V (30.0)	118 ± 6	8779	3918	1499

[1] Rape seed in % of the feed mixtures
[2] Datas from Brettschneider (2006)
[3] Calculations on the basis of feed intake and fatty acid contents of the feed mixtures (tab. 2)

The fatty acid profile of the egg yolk fat in group I (table 3) fed the low-fat diet corresponded to reference data obtained for such a feeding system in laying hens (Jeroch, 1995, Ternes et al., 1994). An increase in the rape seed content of diets significantly affected the fatty acid profile of the egg yolk fat. This was also demonstrated by Niemiec et al. (1999). The concentrations of saturated acids decreased, whereas the levels of linoleic acid and alpha–linolenic acid increased. The changes were greater in the case of alpha–linolenic acid. Elevated levels of rape seed in the ration resulted in the narrowing of the n-6 to n-3 fatty acid ratio. The content of monounsaturated oleic acid remained almost unchanged.

The concentrations of n-6 and n-3 fatty acids in the hen egg are presented in table 4. In group V the concentrations of n-6 and n-3 fatty acids increased by 59 % and 142 % respectively, as compared with group I. In consequence, the ratio between both groups of fatty acids became more narrow, thus meeting the latest recommendations (D-A-CH, 2005).

Table 3. **Fatty acid composition of the egg fat (average value from the whole experiment)**

Group		Fatty acid									
		Myristic (C 14:0)	Palmitic (C 16:0)	Palmito-leic (C 14:1)	Stearic (C 18:0)	Oleic (C 18:1)	Linoleic (C 18:2)	Linole-nic (C 18:3)	Arachido-nic (C 20:4 n-3)	Eicosapen-taenoic (C 20:5 n-3)	Docosahexae-noic (C 22:6 n-3)
I	(0 [1])	0.4 [b] ± 0.05	21.6 [d] ± 1.03	4.2 [c] ± 1.21	5.6 [c] ± 0.32	44.5 ± 0.63	9.3 [a] ± 1.80	0.8 [a] ± 0.49	0.28 ± 0.18	0.05 ± 0.02	0.35 [a] ± 0.12
II	(7.5)	0.3 [b] ± 0.01	20.4 [cd] ± 0.18	3.0 [bc] ± 0.34	5.3 [bc] ± 0.12	44.4 ± 0.48	11.0 [ab] ± 0.54	1.3 [a] ± 0.13	0.22 ± 0.18	0.05 ± 0.02	0.48 [b] ± 0.04
III	(15.0)	0.3 [b] ± 0.01	18.8 [bc] ± 0.63	2.4 [ab] ± 0.15	4.8 [ab] ± 0.10	44.6 ± 0.37	12.7 [bc] ± 0.43	1.8 [ab] ± 0.16	0.28 ± 0.21	0.06 ± 0.01	0.56 [bc] ± 0.06
IV	(22.5)	0.2 [a] ± 0.02	17.8 [ab] ± 1.11	2.2 [ab] ± 0.50	4.5 [a] ± 0.31	45.1 ± 0.87	13.6 [c] ± 0.90	2.1 [bc] ± 0.31	0.34 ± 0.19	0.06 ± 0.02	0.55 [bc] ± 0.01
V	(30.0)	0.2 [a] ± 0.04	16.8 [a] ± 1.62	1.3 [a] ± 0.29	4.3 [a] ± 0.44	45.3 ± 1.07	14.6 [c] ± 1.13	2.3 [c] ± 0.37	0.32 ± 0.18	0.07 ± 0.02	0.61 [c] ± 0.01

[1] Rape seed in % of the feed mixtures ±

Table 4. **Contents of n-6- and n-3-fatty acids in the egg**

Group		Fatty acids in mg/60g egg							ratio ∑ n-6: ∑ n-3
		C 18:2	C 18:3	C 20:4	C 20:5	C 22:6	∑ n-6	∑n-3	
		(n-6)	(n-3)	(n-6)	(n-3)	(n-3)			1 :
I	(0 [1)])	540	46	16	3	20	564	75	7.5
II	(7.5)	651	77	17	3	28	675	112	6.0
III	(15.0)	754	107	17	4	33	784	148	5.3
IV	(22.5)	804	124	20	4	33	839	165	5.1
V	(30.0)	857	135	19	4	36	898	182	4.9

[1)] Rape seed in % of the feed mixtures

The concentrations of n-6 and n-3 fatty acids in the hen egg are presented in table 4. In group V the concentrations of n-6 and n-3 fatty acids increased by 59 % and 142 % respectively, as compared with group I. In consequence, the ratio between both groups of fatty acids became more narrow, thus meeting the latest recommendations (D-A-CH, 2005).

Both our results and those reported by other authors (Nollet, 2001) indicate that rape seed oil contributes to an improvement in the nutritive value of hen eggs. According to Brettschneider (2006), diets for laying hens can be supplemented with up to 15 % of hydro-thermal treated rape seed. At this level of rape seed oil, eggs contain about 150 mg of n-3 fatty acids.

Higher levels of rape seed in layer diets can be used when the content of glucosinulates in rape seed will more decrease (Jeroch, 2005). Laying hens strains without these genetic defect and with a rich capacity of trimethylaminoxidase in metabolism also can be feed by diets with higher levels of rape seed (Dänicke et al. 2006).

Conclusions

Fatty acid profile of egg yolk was influenced by dose-response fatty acid profile of rape seed fat. Higher amounts of healthy n-3 and n-6 fatty acid of rape seed turned over to egg yolk. Because of this, nutritional value in rape seed fed brown eggs was improved. Those modified eggs can optimise human supply of n-3 fatty acids in the food by an regular consumption.

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