Influence of full fat rape seed on the fatty acid profile of egg yolk fat (Q1)

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Abstract

A feeding trial with brown laying hens (Lohmann Brown) was carried out at inclusion levels of 0 % (I), 7.5 % (II), 15 % (III), 22.5 % (IV) and 30 % (V) chemical and hydrothermical treated full fat rape seed in the diets. The diets were based on wheat and soybean meal and fed to 72 hens per group during the period from 27th to 62nd week of age.

The fatty acid profile of egg yolk was markedly influenced by rape seed oil. Despite eggs of group I (without rape seed) the content of saturated fatty acids in the yolk fat decreased and the content of n-6 and n-3 fatty acids increased by increasing inclusion levels of full fat rape seed in the diets. Because the n-3 fatty acids level increased more rapidly than n-6 acids, the ratio n-6 to n-3 fatty acids in the egg was narrowed.

Key words: laying hens, full fat rape seed, egg yolk, fatty acids

Introduction

The human consumption of n-3 fatty acids (also called omega-3 fatty acids) is lower than the recommendations, still insufficient and it can cause the occurrence of heart-related diseases (Jahreis, 2003). It is known that the fatty acid profile of eggs can be modified by feeding of hens (Ternes et al., 1994). In the last decade trials were carried out in order to enrich the hen eggs with those essential fatty acids, especially n-3 fatty acids (Brettschneider, 2006). However, there was indication of sensoric deviations in hens eggs by using of fish or flaxseed oil in hen diets (Scheideler et al., 1997, Van Elswyk et al., 1995). The rape seed oil is also rich in alpha-linolenic acid with very low ratio of linoleic n-6 fatty acid to α-linolenic n-3 fatty acid 1.7 to 1 (Jahreis, 2003). Therefore, in experiments with full fat rape seed as compound in laying hen diets should also be confirmed the thesis of the influence of fatty acid profile in egg by intake of oil in full fat rape seed.

Materials and Methods

Chemical and hydrothermical treated rape seed from "LIRAJET" double zero strain was tested in a feeding trial with Lohmann Brown laying hens. Rape seed was included in the levels of 0 % (group I), 7.5 % (group II), 15 % (group III), 22.5 % (group IV) and 30 % (group V). The experimental diets contained wheat, soybean meal, wheat bran (Table 1). The rape seed contained < 50 mg sinapine and 1,4 mmol glucosinolate/ kg (91 % dm).

Table 1. Composition of the experimental diets

Components (g/kg)	Group				
	I	II	III	IV	V
Wheat	779	628	487	304	136
Wheat bran	-	79	162	304	418
Soybean meal		84	97	38	44
HP - soybean meal	124	38	10	36	11
Rape seed	-	75	150	225	300
Calcium carbonate	69	72	74	76	77
Calcium phosphate	14	11	8	6	3
L-Lysine-HCl	2	1	1	-	-
DL-Methionine	1	1	-	-	-
Sodium chloride	1	1	1	1	1
Premix [1]	10	10	10	10	10
Composition (*calculated, ** - analysed)					
AME_N (MJ)*	11.1	11.2	11.3	11.1	11.1
Crude protein**	177.0	180.0	178.5	183.0	182.0
Crude fat**	21.0	57.0	79.5	126.5	156.0

[1] Supplements per kg of diet: 25 mg Fe, 60 mg Mn, 75 mg Zn, 5 mg Cu, 0.5 mg I, 0.1 mg Se, 0.1 mg Co, 10000 IE vit. A, 2000 IE vit. D_3, 10 mg vit. E, 2.5mg vit. K, 1 mg vit. B_1, 4 mg vit. B_2, 3 mg vit. B_6, 10 µg vit. B_{12}, 25 mg niacin, 10 mg pantothenic acid, 400 mg cholin chloride, 5 mg canthaxanthine

Each group was assigned into 8 subgroups of 9 hens each (72 hens per group). All hens were kept in single cages. The subgroups were equal randomised into the 3-floor-batteries. The trial was carried out over 36 weeks (from 27th to 62nd week of age). In intervals of 4 weeks (9 times) 36 eggs from each group were collected for fatty acid profile analysis. After estimation of egg weight the egg yolks were homogenised and frozen dried for analysis. Fat extracts from feeds and eggs were methylated with trimethylsulfoniumhydroxide and the resulting methyl esters were identified from their retention time using a gas-chromatography system (HP 5890 gas-chromatograph, HP 7673 auto sampler, HP 3365 data-station and flame ionisation detector). Analysis of variance and comparisons of mean differences between groups (Tukey HSD-Test) were performed using Statistica for Windows Operating System (Statsoft Inc., 1996).

Results and Discussion

Intake of feed and fatty acids. The daily feed intake was not influenced by rape seed inclusion level (Table 2). By graded inclusion levels of rape seed in the diets the intake of oleic acid, linoleic acid and α-linolenic acid was increased

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

Group	Feed intake	Consumption (mg/hen/day) [2]		
	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] Calculations on the basis of feed intake and fatty acid contents of the feed mixtures

Fatty acids profile of the egg yolk. In table 3 the results from the estimation of the fatty acid profile of egg yolk fat was shown.

Table 3. Fatty acid composition of the egg fat

Fatty acid (%)	Group				
	I (0[1])	II (7.5)	III (15.0)	IV (22.5)	V (30.0)
Myristic	0.4 [b]	0.3 [b]	0.3 [b]	0.2 [a]	0.2 [a]
Palmitic	21.6 [d]	20.4 [cd]	18.8 [bc]	17.8 [ab]	16.8 [a]
Palmitoleic	4.2 [c]	3.0 [bc]	2.4 [ab]	2.2 [ab]	1.3 [a]
Stearic	5.6 [c]	5.3 [bc]	4.8 [ab]	4.5 [a]	4.3 [a]
Oleic	44.5	44.4	44.6	45.1	45.3
Linoleic	9.3 [a]	11.0 [ab]	12.7 [bc]	13.6 [c]	14.6 [c]
α-Linolenic	0.8 [a]	1.3 [a]	1.8 [ab]	2.1 [bc]	2.3 [c]
Arachidonic	0.28	0.22	0.28	0.34	0.32
Eicosapentaenoic	0.05	0.05	0.06	0.06	0.07
Docosahexaenoic	0.35 [a]	0.48 [b]	0.56 [bc]	0.55 [bc]	0.61 [c]

[1] Rape seed in % of the feed mixtures
[a-d] different letters denote significant differences in fatty acid ($p<0.05$)

The fatty acids profile of the control group correlated with references of Ternes et al. (1994). By feeding diets less in fat and rich in carbohydrates (e.g. group I) the self synthesis of fatty acids dominated. In this case saturated chains of fatty acids were deposed in eggs (mainly palmitic C 16:0 and oleic C 18:1). By higher inclusion levels of rape seed into diets the fatty acids profile of egg yolk changed markedly. The level of saturated fatty acids in egg fat decreased and increased both linoleic and α-linolenic fatty acids but the content of oleic acid was not influenced. The content of alpha-linolenic fatty acid increased more than linoleic acid and leaded to decrease of the ratio n-6 to n-3 fatty acids in egg fat at higher inclusion levels of rape seed in the diets. The increased finding of eicosapentaenoic acid (C 20:5 n-3) and docosahexaenoic acid (C 22:6 n-3) was caused by enzyme systems in hen's metabolism. Such polyunsaturated fatty acids were formed (Nollet, 2001) by desaturation and elongation from alpha-linolenic (precursor n-3) and linoleic fatty acids (precursor n-6). This synthesis was not very efficient as shown the content of polyunsaturated fatty acids (Table 3). The content of n-6 and n-3 fatty acids in egg (60 g) was calculated (in groups I – V respectively): 564, 675, 784, 839 and 898 mg n-6 fatty acids and 75, 112, 148, 165 and 182 mg n-3 fatty acids.

Transfer rate of linoleic and alpha-linolenic acid in the egg. The kind of criteria for valuation of the efficiency of modification fatty acid profile in the egg yolk by rape seed oil could be the transfer rate of the essential fatty acids from feed to egg yolk (Table 4). High transfer (%) of polyunsaturated (C 18:2 and C 18:3) fatty acids was found in group I and the transfer (%) decreased markedly at higher intake of linoleic and alpha-linolenic acids. Eder et al. (1998) estimated a transfer rate for alpha-linolenic acid between 15 and 20 % when the hen's diet contains 10 % flaxseed or 10 % flaxseed oil.

Table 4. Transfer of linoleic (C 18:2, n-6) and α-linolenic (C 18:3, n-3) acids from the feed into the egg

Items	Group				
	I (0[1])	II (7.5)	III (15.0)	IV (22.5)	V (30.0)
Intake (mg/hen/day):					
Linoleic acid	936	1806	2438	3368	3918
α-Linolenic acid	54	391	805	1154	1499
Daily egg mass production (g/hen)	54.6	54.2	53.3	52.2	49.2
Content in daily egg mass (mg):					
Linoleic acid	491	588	670	699	703
α-Linolenic acid	42	70	95	108	111
Transfer (%):					
Linoleic acid	52	33	27	20	18
α-Linolenic acid	78	18	12	9	7

[1] Rape seed in % of the feed mixtures

Conclusions

An improvement of dietetic value of eggs by including 15% of rape seed (practice recommendation of treated rape seed for brown layers) in feed was shown and egg contains 148 mg n-3 fatty acids. The continuous consumption of such eggs can improve the ratio of n-6 to n-3 fatty acids in the human nutrition.

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