

Effect of *Camelina sativa* cake on fatty acid composition of egg yolk and sensory quality of eggs

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Camelina sativa or false flax is an old oil seed plant that has regained interest due to its favourable fatty acid (FA) composition. *Camelina sativa* cake (CSC) is a potential source of omega FAs (n-FAs) in layer diets designed to produce n-3-enriched eggs. An experiment was conducted to study the effects of CSC on FA composition and sensory quality of egg yolk. 54 LSL hens were divided to three groups. The control group was fed diet consisting of grains, soybean meal, rapeseed oil, minerals and vitamins. The two experimental groups were fed diets where part of the soybean meal was replaced with either 50 or 150 g CSC/kg feed, respectively. All diets had equal protein and energy content. A three weeks acclimation period was followed by a three weeks collection period. Egg production and feed consumption was monitored over the experiment.

Yolk FAs were analysed as their methyl esters. A pooled sample of five yolks was analysed and replicated. A panel of ten evaluators did sensory evaluation of egg yolk from hard-boiled eggs in a combined triangle test with comparison test. Three eggs, of which one was from a different group than the other two, was presented to each evaluator. Panellists were asked to tell the divergent sample and to rate its taste and aroma in relation to the other two.

The egg production of all groups remained on the level observed before the experiment. Slight reduction of feed intake was found with dietary CSC inclusion. The proportion of n-3-FAs in egg yolk was higher in CSC groups than in control group. The ratio of n-6:n-3-FAs in egg yolk also changed for better with CSC feeds. The sensory tests revealed no significant effects of CSC inclusion in diet.

In conclusion CSC can be used for production of n-3-enriched eggs without detrimental effects on sensory quality. The effects of CSC on feed intake and production of layer hens requires further research. Due to possible presence of anti-nutritive substances in CSC, the effects of long-term use on hens should also be studied.

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Keywords: laying hens; gold of pleasure; false flax; omega-3 acids; sensory quality of eggs

Introduction

Camelina sativa or false flax is an old cruciferous oil-seed plant that has recently gained interest because of its desirable fatty acid (FA) composition. *Camelina sativa* has high percentage of omega-3 (n-3) fatty acids, especially alpha-linolenic acid (ALA, 18:3 n-3). ALA and products of its desaturation and elongation, namely eicosapentaenoic acid (EPA, 20:5 n-3) and docosahexaenoic acid (DHA, 22:6 n-3), are known for their health promoting effects. From oil-pressing process, in which camelina oil is produced, originates a by-product: *Camelina sativa* cake (CSC). CSC is rich in protein and still has quite high oil content (about 20% crude fat).

High n-6:n-3-ratio in human diet is associated with many diseases such as cardiovascular disease, diabetes, rheumatoid arthritis and even cancer (Simopoulos 2004). Means to reduce n-6-FAs and increase n-3-FAs in human diet are needed. Omega enriched eggs are one possible way to balance n-6:n-3-ratio of diet. Fatty acid profile of hen eggs alters in response to fatty acid profile of hens' diet:

for example camelina oil inclusion in layer diet results in n-3-enriched eggs (Rokka et al. 2001). However, alterations of the fatty acid contents of eggs may cause off-tastes in the eggs. In addition, camelina seeds contain some anti-nutritive substances such as tannins, glucosinolates and sinapins (Matthäus and Zubr 2000). Because of these anti-nutritive substances, CSC is not approved feedstuff in the EU. According to Matthäus and Zubr (2000), however, CSC could be suitable protein source for poultry. Adding CSC to layer diets would probably result in eggs with higher n-3-FA content. The aim of this experiment was to study the effects of CSC in layer hen diet on the FA profile and sensory quality of the eggs produced.

Materials and methods

In this experiment 57 LSL hens (aged 48 weeks) received one of the three different diets. The three diets were: control diet (without CSC), 5% CSC diet and 15% CSC diets. See table 1 for feed ingredients and chemical composition. Hens were housed in battery cages, three hens per cage and they were allowed *ad libitum* feed and water. Mean egg production and feed intake was calculated over the experiment. The experiment consisted of a three weeks acclimation period and a three weeks collection period. Egg samples were stored at +6 centigrade.

Table 1. Feed ingredients and chemical composition.

Treatment	1	2	3
CSC ¹⁾ , %	0	5	15
Barley	48.92	46.39	41.43
Wheat	10.00	10.00	10.00
Oats	10.00	10.00	10.00
Soybean meal	16.80	14.00	8.30
Rapeseed oil	3.00	3.30	3.90
Monocalciumphosphate	1.90	1.90	1.90
Limestone	8.50	8.50	8.50
NaCl	0.38	0.38	0.38
Trace element pre-mix	0.20	0.20	0.20
Vitamin pre-mix	0.20	0.20	0.20
Methionine	0.10	0.10	0.10
Lysine	0.00	0.03	0.09
Camelina cake	0.00	5.00	15.00
Calculated energy content			
ME, MJ/kg	10.87	10.88	10.88
Analysed chemical composition:			
Dry matter (DM), g/kg feed	902.6	902.1	906.1
Ash, g/kg DM	139.4	140.2	139.1
Crude protein, g/kg DM	178.7	179.2	179.6
Crude fat, g/kg DM	60.1	73.4	95.5
Crude fibre, g/kg DM	45.4	44.6	51.0

1) CSC = *Camelina sativa* cake.

Yolks from five eggs from each treatment were pooled for FA-analyses. FAs were analysed as their methyl esters by gas chromatography as described by Rokka et al. (2001).

A panel of ten evaluators evaluated sensory quality of egg yolk from hard-boiled eggs in a combined triangle test with comparison test. In this test each evaluator received three boiled eggs, of which one was from a different treatment than the other two. Panellists tried to tell the divergent sample and rated its taste and aroma in a scale from -2 (clearly worse) to +2 (clearly better) in relation to the other two samples.

Results from FA-analyses were subjected to Tukey's Studentized Range (HSD) Test (SAS Institute Inc., Cary, NC, USA).

Results and discussion

Table 2 shows a comparison of egg yolk FA-profiles from different treatments. Most remarkable change in yolk FAs was evident in the content of ALA, which in eggs from the 15% CSC treatment was almost three fold higher than in eggs from control treatment. Rokka et al. (2001) reported that inclusion of 5% of camelina oil in layer diet resulted in considerable increase of ALA in egg yolk fat from 0.60% in control eggs to 5.02% in 5% camelina oil treatment eggs. As expected, inclusion of CSC in layer diet increased ALA less than inclusion of Camelina oil because CSC used in this experiment had crude fat content of 18.5%. Given this fat content, inclusion of 150 g/kg feed of CSC equals inclusion of 27.8 g of camelina oil per kilogram feed (0.185 x 150 g). Our control treatment resulted in eggs with higher (1.02%) ALA in yolk fat than the control treatment in study of Rokka et al. (2001). Rapeseed oil, which is rich in ALA, made up 3% of the control diet in our study and 3.3 and 3.9% of the CSC diets. Higher rapeseed oil content in CSC diets may account for part of the elevated ALA in yolk fat of the CSC treatment eggs (see tables 1 and 2).

Table 2. Fatty acid composition of egg yolk lipids from different treatments.

Treatment CSC ¹⁾ , %	1 0		2 5		3 15	
	Mean	Sd ²⁾	Mean	Sd ²⁾	Mean	Sd ²⁾
Fatty acid (%)						
C16:0	23.41	0.06	22.68	0.03	21.13	0.04
C16:1/C17:0	2.93	0.11	2.82	0.03	2.48	0.03
C18:0	9.57	0.05	9.18	0.05	9.50	0.13
C18:1	45.72	0.14	44.87	0.04	45.58	0.16
C18:2 n-6	12.37	0.01	13.51	0.02	13.55	0.11
C18:3 n-3	1.02	0.00	2.04	0.01	2.87	0.07
C20:4 n-6	1.87	0.03	1.44	0.02	1.20	0.00
C20:5 n-3	-	-	0.07	0.01	0.07	0.00
C22:5 n-3	0.13	0.01	0.17	0.00	0.20	0.01
C22:6 n-3	1.51	0.02	1.62	0.04	1.74	0.05
Total n-3	2.82		4.06		5.04	
Total n-6	14.57		15.32		15.04	
n-6:n-3-ratio	5.17		3.77		2.98	

1) CSC = *Camelina sativa* cake.

2) Standard deviation, n=5 eggs per treatment.

Table 3. Success in recognizing the divergent sample by panellists in combined triangle test with comparison test, and comments from succeeded panellists on taste, odour and general pleasantness of egg yolks from camelina treatments in comparison to control treatment.

Panellist	Test							
	Control vs. 5% CSC ¹⁾				Control vs. 15% CSC ¹⁾			
	Right/ Wrong	Taste ²⁾	Odour ²⁾	Pleasantness ²⁾	Right/ Wrong	Taste ²⁾	Odour ²⁾	Pleasantness ²⁾
1	W				R	+1	+1	+1
2	R	+1	+1	+1	W			
3	W				R	-1		
4	R	-1		-1	W			
5	W				R	_ ³⁾	_ ³⁾	_ ³⁾
6	R	+2		+2	R	+1	+2	+2
7	W				W			
8	R	-1		-1	W			
9	W				W			
10	R	-2		-1	R	+1		+1

1) CSC = *Camelina sativa* cake.

2) Figures represent sensory characteristics of egg yolks from camelina treatments in comparison to control treatment: positive figures mean that panellist in question preferred camelina eggs over control eggs and negative figures mean that the panellist preferred control eggs over camelina eggs.

3) No comments on taste, odour or pleasantness

A notable change was evident also in egg yolk fat n-6:n-3-ratio. CSC diets resulted in lower n-6:n-3-ratio in egg yolk than control diet due to their higher n-3-FA content. Similar effect was evident in the experiment of Rokka et al. (2001) on camelina oil.

Results from sensory quality tests are presented in table 3. The assessments of taste, odour and general pleasantness of egg yolk from those panellists who were able to distinguish the divergent sample are also presented. In both comparison tests only five out of the ten evaluators were able to distinguish the divergent egg sample. Only two panellists succeeded in both comparison tests and only one of them was consistent in her rating of the eggs from control and CSC diets. These results suggest that CSC inclusion in layer diet does not affect the sensory quality of eggs.

Because only one observation per treatment was available of production and feed intake data, we were not able to perform statistical analysis. However, production rate remained on level observed before the experiment started even in groups receiving CSC diets. However, in groups receiving CSC diets a slight reduction in daily feed intake was evident when compared to their feed intake before the experiment.

In conclusion, CSC seems to be suitable feed ingredient for laying hens. CSC inclusion adds protein and sulphurous amino acids to feed and CSC can replace at least part of soybean meal. In addition, the high n-3-FA content of CSC ameliorates eggs' FA-profile, especially n-6:n-3-ratio, without significant effects on eggs' sensory quality.

References

- MATTHÄUS, B. and ZUBR, J.** (2000) Variability of specific components in *Camelina sativa* oilseed cakes. *Industrial Crops and Products* **12**: 9–18.
- ROKKA, T., ALÉN, K., VALAJA, J. and RYHÄNEN, E.-L.** (2002) The effect of a *Camelina sativa* enriched diet on the composition and sensory quality of hen eggs. *Food Research International* **35**: 253–256.
- SIMOPOULOS, A.P.** (2004) Omega-6/Omega-3 essential fatty acid ratio and chronic diseases. *Food Reviews International* **20**: 77–90.