GROWTH PERFORMANCE, MEAT QUALITY AND CARCASS COMPOSITION OF BROILERS FED RAPESEED-ENRICHED DIETS

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Abstract – This paper describes the effect of a diet containing 15% rapeseed on growth performance, carcass composition, fatty acid composition, volatiles and sensory meat quality attributes on broilers. Overall, the broilers perform well on the rapeseed meal diet.

Key Words – Rapeseed-enriched broiler feed, Growth performance, Meat and carcass quality.

I. INTRODUCTION

The majority of European broiler production's need for protein is today covered by imported soybean meal. Using imported soy in animal production is questioned, and limiting its use for European meat production is therefore in focus. Replacing imported soy protein by domestic protein, could be one way to strengthen the European broiler brand. Rapeseed is a protein crop that is grown in many EU states, including Denmark, and there are therefore great opportunities to increase its use in broiler production. Furthermore, replacing soybean meal with rapeseed could also result in cheaper broiler feed. The aim of the present study was to compare the growth performance, foot pad quality, carcass composition and meat flavour in broilers fed diets including 0, or 15% rapeseed meal from days 11 to day 32. The broilers were slaughtered at day 34.

II. MATERIALS AND METHODS

Birds and production: In total 720 broilers of the breed Ross 308 were divided into 12 pens, each containing 60 broilers. There were 30 males and 30 females in each pen. The birds were raised on a conventional broiler farm.

Broiler diets: The two diets tested were both based on soybean meal, wheat and corn and both contained the coccidiostat salinomycin. The control diet contained 0% rapeseed meal, while the test diet contained 15% rapeseed meal. Diets were optimized to be equal regarding energy and protein. The rapeseed in the test diet replaced a part of the wheat, soy, and maize gluten meal. From day 6 to the end of the experiment, the feed was diluted with whole wheat starting with an inclusion rate of 6 % and then increasing to a whole wheat inclusion rate of 24%. The last 2 days before slaughter, the birds were fed a finishing diet without any rapeseed meal and without any coccidiostat.

Dietary fatty acid composition: The lipids were extracted using chloroform/methanol solution (2:1, v/v), followed by homogenization. The chloroform phase was used for fatty acid composition (FAME) analysis. The methylated fatty acids were analysed on the gas chromatograph using an Omegawax column and FID detection. The data was analysed using Chemstation software (Agilent Technologies) and the fatty acid methyl esters were identified by comparing retention times with known standards. The results were expressed as % fatty acid of the total content of detected fatty acids.

Performance and carcass quality: For carcass studies, 7 males and 7 females were randomly marked in each of the boxes at day 0. All the broilers in each pen were weighed during their time in the box on days 0 (start), 7, 14, 28 and 32. Feed consumption, mortality-rate and foot pad health were also registered. Feed conversion corrected for mortality (FCR-corr) was calculated based on a standard curve for daily weight gain. On day 33, the broilers were placed in slaughter boxes, and on the next day (day 34) they arrived at the commercial slaughter plant ”Sødam Øko Fjerkræslagteri” where they were electrically stunned and slaughtered. On Day 36, the carcasses were cut according to the standard method described by Darré and Claudi-Magnussen et al. (DMRI, unpublished).

Sensory evaluation: A descriptive sensory analysis was carried out with a trained sensory panel (n=10). In order to simulate the fresh meat quality typically found on shop display, the samples from both feeding regimes were stored at +2ºC for 6, 7, 8 and 10 consecutive days prior to cooking. The *pectoralis major* muscles were partitioned in a left and right part. For each broiler one part was frozen (control day 6) and the other part stored refrigerated at +2ºC until the respective storage day. On the day of assessment the frozen control samples were thawed out and together with the refrigerated samples cooked sous-vide in a water bath to a core temperature of 63ºC. Samples were subsequently held at 10 min (60ºC) before unpacking, slicing and serving to the panel. All samples were evaluated in four replicates over four sessions. The day 6 control (with and without rapeseed-enriched diet) were present in all sessions. Within each session the sample presentation order was randomised.

Analysis of volatiles: When meat samples were cooked for sensory testing, extra samples were prepared simultaneously for analysis of volatiles. For each of the two test diets, 12 samples stored for 6 days were analysed together with four samples stored for either 7, 8 or 9 days (48 samples in total). Dynamic headspace sampling followed by thermal desorption of traps to a GC-MS system was applied (procedure slightly modified from [1].

Data analysis: The data was analysed using ANOVA (Proc. Mixed, SAS, 9.4) where the fixed effects of diet and sex were included in the model. For the analyses of performance during growth the model included the fixed effect of Day of measurement. Least-squares means and standard error of the means were calculated. A p-value less than 0.05, was considered as a significant difference.

III. RESULTS AND DISCUSSION

Performance and carcass quality: Using rapeseed in the diet had no effect on the performance indicators registered (Tables 1-2) or on carcass quality attributes (Table 3). Expected differences between sex were also found in this study (Table 4).

Table 1. The effect of diet overall and at 32 days age on broiler performance (LS-means and SE).

Attribute	Diet		SE	p-value
	No-Rapeseed	15%-Rapeseed		
Mortality, %	3.4	3.9	0.62	0.97
Mortality-Day32, %	3.9	4.7	1.42	0.71
FCR, kg/kg	1.14^{a}	1.15^{b}	0.003	0.017*
FCR-Day32, kg/kg	1.42	1.44	0,007	0,055
FCR-corr, kg/kg	1.13^{a}	1.14^{b}	0.003	0.050*
FCR-corr-Day32 kg/kg	1,41	1,43	0,008	0,138
Food pad score-Day 28	0.4	1.6	1.2	0.48
Weight-Day32, g	1957	1906	29	0.24

Table 2. The overall effect of age on performance (LS-means and SE).

Attribute	Day				SE	p-value
	7	14	28	32		
Mortality, %	2.8	3.5	4.2	4.3	12.93	0.59
Weight, g	171^{a}	450^{b}	1574^{c}	1931^{d}	20.8	<0.0001***
FCR, kg/kg	0.75^{a}	1.06^{b}	1.34^{c}	$1. 43^{d}$	0.004	<0.0001***
FCR-corr, kg/kg	0.74^{a}	1.05^{b}	1.33^{c}	1.42^{d}	0.005	<0.0001***

Table 3. The overall effect of diet on carcass quality (LS-means and SE).

Attribute	Diet		SE	p-value
	No-Rapeseed	15%-Rapeseed		
Live wgt, g	1982	1916	35.5	0.22
Carcass wgt, g	1438	1377	28.0	0.15
Dressing-%	72.2	72.0	0.3	0.55
Fillet, g	486.5	498.6	3.5	0.99
Fillet, %	34.3	34.4	0.2	0.71
Thigh, g	250.6	251.4	1.9	0.78
Drumstick, g	179.7	178.9	1.2	0.70
Wings, g	123.4	124.7	0.7	0.21
Neck+wingpoints, g	17.3[a]	18.2[b]	0.3	0.045*
Skin+Skinfat, g	45.5[a]	42.9[b]	0.8	0.047*

Table 4.The overall effect of sex on slaughter quality (LS-means and SE).

Attribute	Sex		SE	p-value
	Male	Female		
Live wgt, g	2085[a]	1814[b]	31.2	<0.0001***
Carcass wgt, g	1509[a]	1306[b]	25.0	<0.0001***
Dressing-%	71.6[a]	72.6[b]	0.3	0.0033**
Fillet, g	474.4[a]	498.6[b]	3.5	<0.0001***
Fillet, %	33.3[a]	35.3[b]	0.2	<0.0001***
Thigh, g	252.9	249.1	1.8	0.12
Drumstick, g	184.0	174.6	1.2	<0.0001***
Wings, g	125.6[a]	122.5[b]	0.7	0.0058**
Neck+wingpoints, g	18.5[a]	17.1[b]	0.2	<0.0001***
Skin+Skinfat, g	41.8[a]	46.6[b]	0.9	0.0003***

Diet fatty acid composition (FAME) The effect of rapeseed on the fatty acid profile of the meat is shown in Table 5. Diets including 15% rapeseed had an effect on the fatty acid profile of the meat, where it increased the contents of mono and poly unsaturated fatty acids. There was no difference in saturated fatty acid contents or the total fat contents when including rapeseed in the diet. This is in line with what was expected as fatty acid profile in chickens is strongly related to the fatty acid of the diet.

Table 5. Effect of diet on fatty acid composition of the meat (LS-means and SE)

Diet	C16:0, %	C18:0, %	C18:1, %	C18:2, %	C18:3, %	Total fat, %
0% rapeseed	13,43±0,03	1,72±0,12	28,36[a]±0,15	51,39[a]±0,06	5,10[a]±0,01	7,20±0,70
15% rapeseed	13,38±0,03	1,40±0,12	25,41[b]±0,15	54,91[b]±0,06	4,90[b]±0,01	6.30±0,70
p-value	0,3906	0,2026	0,0051**	0,0006***	0,0097**	0,4573

All broilers performed well and the health status was generally good. The foot pad score was very low in both treatments indicating that the test diet did not have any negative impact on the digestion. FCR was highest on the test diet and overall production performance was best on the control diet.

Replacing part of soybean meal with 15% rapeseed meal did not have an influence on total fat content of the meat, as well as the concentrations of the saturated fatty acids found (C16:0 and C18) in the diets. The concentration of MUFA (C18:1) was reduced when using rapeseed meal. Regarding concentrations of PUFA, C18:2 was increased and C18:3 was reduced in the diet when using rapeseed meal. It is well-known that the fatty acid composition found in meat from birds, is to a very high degree reflecting the fatty acid composition in the diet. Therefore it is expected to find the similar changes in the meat when using rapeseed meal in the bird's diet.

Sensory study: The effect of broiler diet showed a significant effect at day 10 for crumbliness (p=.025) with the rapeseed fed broilers scoring significantly higher on this attribute. The effect of storage days at each diet regime was significant for the attribute sweet (*p*=.024) for the control diet only. In this case the sweetness was scored significantly higher after ageing the meat refrigerated for 10 days. When modelling within the sensory evaluation sessions more sensory differences could be observed, but these could not be clearly separated from the variability in the assessment of the control samples (Day 6). Therefore the overall measurable sensory differences were judged to be relatively small with only effects occurring at the prolonged (Day 10) refrigerated storage.

Volatiles: In total, 69 volatile compounds could be detected in the cooked meat samples. No effect was seen from storage prior to cooking, but 27 compounds were significantly influenced by the broilers' diet. Almost all of these compounds are related to lipid oxidation (see Fig. 1; aldehydes, alcohols, ketones and alkanes), and they had all higher levels in meat from broilers given the 15%-rapeseed meal diet. Many of the compounds are suspected to cause off-flavour in meat, for example hexanal [2], but when comparing with the results of the sensory test, it can be concluded that the levels were not high enough to be detected sensorily.

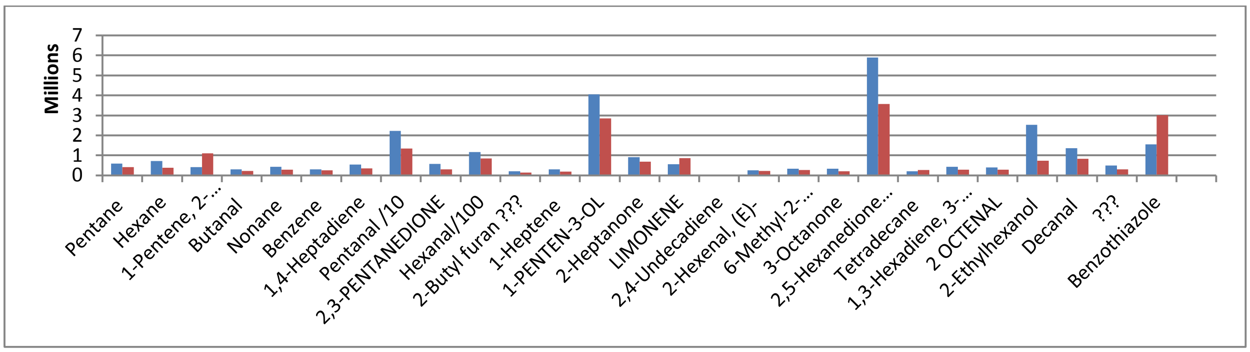

Figure 1. Significant volatile compounds from cooked chicken meat with and without rapeseed in the diets; 15% rapeseed (1st bar) and 0% rapeseed; control (2nd bar).

IV. CONCLUSION

Volatiles: Increased oxidation after feeding rapeseed diets, but not enough to be detected sensorily. Fatty acid composition: Feeding rapeseed did not influence total fat content, as well as the contents of the saturated fatty acids C16:0 and C18. MUFA (C18:1) was reduced in the diet containing rapeseed. PUFA C18:2 was increased, and C18:3 was reduced in the diet when using rapeseed. These results are expected as the fatty acid profile found in chicken meat reflect the fatty acids found in the diet.

Based on the above results, there seem to be no economic advantage to use 15% rapeseed meal in the broiler diet as a replacement for soybean meal. However, the price for rapeseed and soy varies over time, and in this light, the results can be of importance. The broilers perform well on the rapeseed meal diet but not as well as on the control diet. If the price difference between rapeseed meal and soybean meal will be large, the overall production economy could benefit from the use of up to 15 % rapeseed meal in the diet.

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