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Weaner feed with 15% rapeseed cake or rapeseed meal

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Health and productivity did not differ among weaners (11-30 kg) fed soy protein, 15% rapeseed cake. Productivity tended to drop with 15% German or Polish rapeseed meal.

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Abstract

It is possible to add up to 15% rapeseed cake (canola cake) to weaner feed without adversely affecting productivity. Rapeseed meal (canola meal) can also be used, but production value tended to drop when German and Polish rapeseed meal was used (7.3 and 8.3% lower than control, respectively). No differences in health were found between the groups. The current production value (including the current price of the diets) revealed a small difference between control and the groups with rapeseed cake from Scanola and Danraps and German rapeseed meal.

Compared with control, production value dropped by 8% with Emmelev Mølle rapeseed cake and by 13% with Polish rapeseed meal. Consequently, these products are too expensive (autumn 2010) compared with control and the other rapeseed products. With the prices used in this trial (autumn/winter 2010), an economic advantage is obtained by adding approx. 10% rapeseed to weaner diets.

The trial comprised five different rapeseed products available in Denmark (2009):

Group	1	2	3	4	5	6
	Control	Rapeseed cake	Rapeseed cake	Rapeseed cake	Rapeseed meal	Rapeseed meal
	Soybean meal	Scanola A/S	Danraps	Emmelev Mølle	ADM, Germany	Poland

Initial analyses of the rapeseed products revealed differences in the content of feed units (FUgp), lysine and glucosinolates. These results were included in the formulation of the diets. When formulating diets with rapeseed products, it is essential to consider the fact that nutrient content varies to ensure an optimum nutrients composition.

Emmelev Mølle rapeseed cake contained fewer FUgp and less lysine than the other rapeseed cakes. Analyses revealed a lower glucosinolate content in rapeseed cake from Emmelev Mølle and in rapeseed meal from Germany and Poland. This was attributed to more intense heat-treatment during the oil recovery process as these three products had a low content of 4-hydroxy-glucobrassicin. A content of 4-hydroxy-glucobrassicin below 2.0 micromol/g rapeseed product generally indicates that the product was damaged during heat-treatment.

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Background

Rapeseed oil can replace diesel fuel and this has increased the interest in cultivation of rapeseed. Consequently, rapeseed oil prices have soared. When production of rapeseed oil increases, production of by-products such as rapeseed cake and rapeseed meal also increases. Based on amino acid composition, rapeseed protein is a high-value protein for meat production. The biological value compares to fish protein and potato protein. The content of glucosinolates and fibre in rapeseed may adversely affect the pigs' uptake of the protein.

Today, double low rapeseed varieties are grown in Denmark, which are varieties with low content of erucic acid and glucosinolates (under 25 micromol/g rapeseed). Modern varieties have a glucosinolate content of 15-25 micromol/g, but during processing these glucosinolates disintegrate into products that may, to a greater extent than glucosinolates, adversely affect pigs' digestion. However, practical studies made by Scanola A/S in the beginning of the nineties demonstrated that if rapeseed is subject to correct heat-treatment during oil extraction, it is possible to use large quantities of rapeseed

products (up to 24%) in finisher feed [5]. Finisher productivity is adversely affected if rapeseed cakes were damaged during heat-treatment [1], but up to 11% whole rapeseed can be used in finisher feed with a glucosinolate content of 10 micromol/g [2]. This will, however, reduce the fat quality because of the high amount of unsaturated fat in the diet [4].

This trial is part of a comprehensive project called “Optimising the quality of rapeseed cake for use as protein and energy sources in feed for monogastric animals and development of new high-value protein products”, which is a joint venture between LIFE, Copenhagen University; The Faculty of Agricultural Sciences, Aarhus University; DLA Agro; Scanola A/S; and Pig Research Centre. Financial aid was granted to the project by the Innovation Act under the Danish Food Industry Agency.

The aim was to study the rapeseed products available in Denmark in 2010 and analyse their content of protein, fat, energy and glucosinolates, and the effect on pigs’ productivity.

Material and method

The trial was conducted in the weaner units at Experimental Station Grønhøj. The pigs were transferred to the weaner facilities at weaning (approx. five wks old) at an average weight of 7.3 kg. Two weeks after transfer, at an av. weight of 11.0 kg, the actual trial period began. By the end of the trial, the pigs weighed 29.9 kg. The trial comprised six groups and 34 replicates (pens) per group with 309 pigs per treatment (table 1).

Table 1. Trial design.

Group	1	2	3	4	5	6
Piglet diet (7.3-11 kg)	Control	Control	Control	Control	Control	Control
Weaner diet (11-29.9 kg)	Control – Soybean protein	Scanola - rapeseed cake	Danraps – rapeseed cake	Emmelev Mølle - rapeseed cake	ADM, Germany - rapeseed meal	Poland – rapeseed meal

Analyses – rapeseed

The batches used in this trial were purchased in Denmark. Prior to diet formulation, representative samples were taken from rapeseed batches, split according to the TOS principles and subjected to analysis of nutrients (used in the formulation of the trial diets) and glucosinolates. The nutrient content is shown in Appendix 2. One batch from Emmelev Mølle was discarded upon delivery as the rapeseed cake was hot and unable to “flow” out of the big bag it was delivered in. A temperature of 49 °C was recorded in the rapeseed cake. Instead, pelleted rapeseed meal was subsequently delivered from

Emmelev Mølle and used in the trial. The remaining rapeseed cakes and meal were delivered as granulate with varying particle sizes.

Feeding

All pigs were fed ad lib in dry feeders. The first two weeks post-weaning all pigs were given the same diet without any rapeseed products (Danish Prima 7 zinc). After ten days, the pigs gradually switched to the trial diets over four days.

Diets

The diets were formulated with identical nutrient content. The content of the first five amino acids was 5% above the standard, and calcium and phosphorus levels were 10% above the standard [3]. This served as a guarantee against variations in the ingredients that might ultimately affect the result of the trial. The composition of the diets is shown in Appendix 1 and the nutrient content is shown in Appendix 2. All diets were produced by Danish Agro.

Table 2. Content of rapeseed by-products and soybean meal (%).

Group	Control	Rapeseed cake	Rapeseed cake	Rapeseed cake	Rapeseed meal	Rapeseed meal
	Control	Scanola	Danraps	Emmelev Mølle	Germany	Poland
Rapeseed	0	15.0	15.0	15.0	15.0	15.0
Dehulled soybean meal	16.4	10	10.5	10.3	9.2	10.3

Statistical analyses and calculations

Daily gain and feed conversion ratio for each pen were used to calculate the production value per pig (PV) using the same price per analysed FUgp for all groups.

Production value/pig = PV = (sales price ÷ purchase price ÷ feed costs)/feed days per pig.

For calculation of the production value, the below factors were used.

Average pig price of the last 5 years (September 1, 2005 – September 1, 2010):

- Pigs weighing 7 kg: DKK 194 per pig, kg adjustment from 7 kg: DKK +9.44 per kg
- Pigs weighing 30 kg: DKK 334 per pig, kg adjustment: DKK -5.72 per kg (15-30 kg)
- Feed costs (av. of 5 years): weaner feed DKK 1.65 per feed unit
- Various costs: DKK 20
- Value of gain: DKK 5.36 per kg.

Current pig prices 2010 (wks 34-38, 2010):

- Pigs weighing 7 kg: DKK 208 per pig, kg adjustment: 7-9 kg DKK 8.49 per kg. 9-12 kg DKK 7.17 per kg
- Pigs weighing 30 kg: DKK 290 per pig, kg adjustment: DKK 5.91 per kg (25-30 kg).

The trial was designed as a comparison between the five trial groups (2-6) and the control group. The production value was analysed as primary parameter; recordings of disease and mortality were analysed as secondary parameters. Continuous data was described in a generalised linear model with group as systematic effect, weight at transfer as co-variate, and block as random effect. Discrete data (death and treatment) was described with logistic regression with treatment as explaining variable. The results are shown as adjusted average of each group: corrections were made for five pair-wise comparisons. Data was checked for normal distribution, interaction and prevalence of outliers to ensure that no pens deviated significantly.

Results and discussion

Rapeseed products

The nutrient content varied between the products. Crude fat content was three times higher in rapeseed cakes than in rapeseed meal. This is a consequence of the oil extraction process and, as a result, rapeseed meal contained fewer FUgp than rapeseed cake. Rapeseed cake had a protein content of 29-30% and rapeseed meal a protein content of 36-37%. Rapeseed cake from Emmelev Mølle contained significantly less lysine than the other products in spite of a high crude protein content. This may be attributed to intense heat-treatment during which complexes may form between lysine and carbohydrates in rapeseed whereby lysine is no longer digestible or can no longer be analysed. In this trial, the analysed nutrient content of the rapeseed products formed the basis of diet formulation. If this had not been taken into consideration, and if standard values were used, the low lysine content in Emmelev Mølle rapeseed cake could have affected the pigs' productivity negatively because of a lysine deficiency. All analysis results are shown in Appendix 2.

Rapeseed meal contained significantly fewer glucosinolates than rapeseed cake. This is probably due to one of two factors: a rape variety low on glucosinolates was used for production of rapeseed meal, or glucosinolates disintegrated under intense heat-treatment. The content of 4-hydroxy-glucobrassicin was low in Emmelev Mølle rapeseed cake and in the German and Polish rapeseed meal, which indicates intense heat-treatment during oil extraction. A content of 4-hydroxy-glucobrassicin below 2.0 micromol/g rapeseed product is generally an indication that the product was damaged during heat-treatment. The content of 4-hydroxy-glucobrassicin in rapeseed cakes from Danraps and Scanola was above 2.0 micromol/g (cf. table 3).

Table 3. Analysed content of nutrient and glucosinolates (4 analyses).

	Rapeseed cake			Rapeseed meal	
Product	Scanola	Danraps	Emmelev Mølle	Germany	Poland
Glucosinolates, micromol/g	23.0	25.0	14.3	3.7	8.9
4-hydroxy-glucobrassicin, micromol/g	2.1	2.2	0.4	0.2	0.1
FUgp/100 kg	92	92	84	73	79
Crude protein, %	30	30	29	37	36
Lysine, g/kg	17.4	17.1	13.8	20.6	19.2
Crude fat, %	11	11	10	4	3

Feed

The analysed nutrient content of the weaner diet demonstrated good agreement between the calculated and the analysed content (Appendix 2). The lowest lysine content was found in the control diet (12.8 g/kg vs 14.3-13.7 g/kg in the trial diets). Analyses of digestible lysine showed that the control diet lacked 0.3 g st. dig. lysine per FUgp. Based on previous research with lysine for weaners, the effect of this may be that the pigs in group 1 lack 5 g daily gain and 0.03 Fugp/kg gain, which would have had very little effect on production value and no effect on the conclusion.

Health

No differences were found between the groups in mortality and treatments for diarrhoea. The pigs were treated for diarrhoea averagely 1.25 days/pig in the entire trial period. Mortality averaged 0.4%, and 5.8% were moved to a hospital pen.

Productivity

Analyses revealed no differences between the groups in production value (cf. table 4). With German rapeseed meal, production value was 7.3 index points lower and with Polish rapeseed meal 8.3 index points lower than control. This is explained by a lower daily gain and a poorer feed conversion ratio that may have been affected by the disintegration of glucosinolates. These two products tended to be below control in production value, but this difference was eliminated when regard was made to the five pair-wise comparisons.

Table 4. Productivity and production value in the trial period (11.0-29.9 kg)

Group	1	2	3	4	5	6
	Control	Rapseed cake			Rapeseed meal	
	Control	Scanola	Danraps	Emmelev Mølle	Germany	Poland
Daily gain, g/day	549	537	526	536	518	524
Feed intake, FUgp/day	1.03	1.00	0.98	1.01	0.98	1.02
FCR, FUgp/kg	1.87	1.86	1.87	1.88	1.91	1.95
Production value, DKK/pig[1]	70.0	68.8	67.0	67.9	64.9	64.2
Index[1]	100	98.4	95.8	97.0	92.7	91.7

[1)] For a difference in production value to be significantly different, there must be a minimum difference in production value of DKK 6.6 corresponding to 9.4 index points.

Current production value

The current feed prices are based on

- feed prices in the trial period (September 2010),
- 30 tonnes delivery free,
- market prices,
- pig prices wks 34-38, 2010.

Table 5. Feed prices and production value (PV) in the trial period (11.0-29.9 kg) - September/October 2010.

Group	1	2	3	4	5	6
	Control	Rapeseed cake			Rapeseed meal	
	Control	Scanola	Danraps	Emmelev Mølle	Germany	Poland
Price of feed, DKK/FUgp	2.19	2.17	2.17	2.21	2.15	2.17
Current PV, DKK/pig	29.9	30.4	29.4	27.5	28.3	26.0
Index	100	101.5	98.3	92.1	94.6	87.1

Calculations of the current production value, including the price of the diets (October 2010), demonstrated only small differences between control and rapeseed cakes from Scanola and Danraps, and German rapeseed meal. With Emmelev Mølle rapeseed cake, PV was approx. 8% lower, and with Polish rapeseed meal approx. 13% lower than control. Consequently, Polish rapeseed meal and Emmelev Mølle rapeseed cake are too expensive compared with the other rapeseed products in the trial (autumn 2010).

Conclusion

It is possible to use up to 15% rapeseed cake to weaner feed without significantly affecting productivity negatively. It is also a possibility to use rapeseed meal, but production values tended to be 7.3% and 8.3% lower, respectively, with German and Polish rapeseed meal products. No differences were observed in health between the groups. The production value, including the price of the diets (October 2010), demonstrated small differences between control and rapeseed cake from Scanola and Danraps, and rapeseed meal from Germany. With Emmelev Mølle rapeseed cake, production value was approx. 8% lower, and with Polish rapeseed meal production value was approx. 13% lower compared with control. Consequently, Polish rapeseed meal and Emmelev Mølle rapeseed cake are too expensive compared to the other rapeseed products in the trial and soybean meal (autumn 2010). With these prices, an economic advantage can be obtained by adding approx. 10% rapeseed to weaner feed.

Rapeseed meal from Germany and Poland had a low content of 4-hydroxy-glucobrassicin, which indicates that the products were damaged by heat-treatment and that glucosinolates had disintegrated, which affected pigs' productivity negatively.

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Appendix 1

Ingredients, %, in weaners diets

Group	Control	Rapeseed cake	Rapeseed cake	Rapeseed cake	Rapeseed meal	Rapeseed meal
-	Control	Scanola	Danraps	Emmelev Mølle	Germany	Poland
Rapeseed / canola	0	15.0	15.0	15.0	15.0	15.0
Wheat	53.7	45.2	45.0	44.5	45.5	44.4
Barley	15.0	15.0	15.0	15.0	15.0	15.0
Dehulled soybean meal	16.4	10	10.5	10.3	9.2	10.3
Fishmeal	4.0	4.0	4.0	4.0	4.0	4.0
Potato protein	2.9	2.6	2.4	2.7	2.2	1.9
Vegetable oil	2.7	3.3	3.4	3.8	4.3	4.7
Molasses	1.0	1.0	1.0	1.0	1.0	1.0
Dietary salt	0.3	0.3	0.3	0.3	0.3	0.3
Feed lime	0.9	0.8	0.8	0.8	0.9	0.8
Mono calcium phosphate	1.0	0.5	0.5	0.5	0.7	0.6
Phyzyme XP, 4000 TPT	0.025	0.025	0.025	0.025	0.025	0.025
Threonine	0.071	0.050	0.056	0.059	0.058	0.060
Methionine	0.076	0.051	0.047	0.055	0.044	0.045
Lysine	0.335	0.322	0.329	0.370	0.341	0.352
Tryptophan	0.026	0.030	0.030	0.031	0.028	0.027
Aromatic compound	0.010	0.010	0.010	0.010	0.010	0.010
Vitamins	0.40	0.40	0.40	0.40	0.40	0.40
Biopro	1.0	1.0	1.0	1.0	1.0	1.0
Rapeseed cake	0	15	15	15	0	0
Rapeseed meal	0	0	0	0	15	15

Appendix 2

Analyses of nutrient content in the rapeseed by-products (based on average of 4 or 8 analyses)

-	Rapeseed cake			Rapeseed meal	
	Scanola	Danraps	Emmelev Mølle	Germany	Poland
FUgp/100 kg	92	92	84	73	79
Crude protein, %	29.8	29.9	29.1	36.7	35.5
Crude fat, %	10.8	11.0	9.7	3.6	2.6
Calcium,g/kg[1]	8.9	8.6	9.3	6.6	8.1
Phosphorus, g/kg[1]	12.9	12.7	13.7	11.5	12.1
Lysine, g/kg	17.4	17.1	13.8	20.6	19.2
Methionine, g/kg	5.9	6.3	5.5	7.3	7.3
Cystine, g/kg	7.2	7.5	5.9	8.5	8.2
Threonine, g/kg	13.4	13.2	12.4	15.7	15.3
Isoleucine, g/kg	11.0	11.4	10.9	13.6	13.6
Leucine, g/kg	20.4	19.9	19.3	25.0	23.9
Histidine, g/kg	7.7	8.2	7.3	9.6	9.5
Phenylalanine, g/kg	11.7	12.0	11.3	14.2	14.4
Tyrosine, g/kg	9.4	9.1	9.2	11.3	10.9
Valine, g/kg	14.4	14.8	14.2	17.7	17.7
Asparginic acid, g/kg	22.0	20.4	19.9	25.9	25.3
Serine, g/kg	13.1	12.8	11.7	15.6	15.0
Glutamic acid, g/kg	48.1	44.4	44.3	60.6	55.3
Proline, g/kg	17.7	19.1	17.2	22.1	21.9
Glycine, g/kg	15.1	14.6	14.5	18.0	17.4
Alanine, g/kg	13.1	12.7	12.5	15.7	15.0
Arginine, g/kg	17.4	17.5	14.7	21.3	20.9

[1] Average of 8 analyses.

Analyses of nutrients in weaner feed, 2 batches (based on average of 3 or 4 analyses).

-	Group 1 – Soybean meal		Group 2 – Scanola rapeseed cake		Group 3 – Danraps rapeseed cake	
-	Calculated	Analysed	Calculated	Analysed	Calculated	Analysed
FUgp/100 kg	115	115	115	115	115	115
Crude protein,%	20.2	19.1	20.7	20.5	20.7	20.3
Crude fat, %	5.0	5.1	6.9	7.0	7.0	7.1
Calcium, g/kg[1]	10.1	8.5	10.1	8.6	10.1	8.5
Phosphorus, g/kg[1]	6.6	6.2	6.8	6.1	6.8	6.0
Lysine, g/kg	13.4	12.8	13.7	13.5	13.7	13.4
Methionine, g/kg	4.2	4.1	4.2	4.3	4.2	4.2
Cystine, g/kg	3.3	3.1	3.8	3.6	3.9	3.6
Meth+cys, g/kg	7.5	7.2	8.0	7.8	8.1	7.8
Threonine, g/kg	8.3	7.9	8.6	8.6	8.5	8.4
Valine, g/kg	9.8	9.4	10.1	9.9	10.1	9.6
Phytase activity, FTU[2]	1000	1857	1000	2114	1000	1462

[1] Average of 3 analyses.

[2] Average of 2 batches. Group 1: 975-2739 FTU. Group 2: 1250-2977 FTU. Group 3: 1572-1351 FTU.

-	Group 4 – Emmelev Mølle rapeseed cake		Group 5 – German rapeseed meal		Group 6 – Polish rapeseed meal	
-	Calculated	Analysed	Calculated	Analysed	Calculated	Analysed
FUgp/100 kg	115	115	115	116	115	115
Crude protein,%	20.7	20.2	21.0	20.5	20.9	20.5
Crude fat, %	7.2	7.6	6.8	7.2	7.0	7.5
Calcium, g/kg[1]	10.1	8.7	10.1	9.1	10.1	8.6
Phosphorus, g/kg[1]	6.8	6.1	6.8	6.3	6.8	6.3
Lysine, g/kg	13.6	13.4	13.8	13.7	13.7	13.6
Methionine, g/kg	4.2	4.2	4.2	4.3	4.2	4.3
Cystine, g/kg	3.6	3.5	3.9	3.8	3.9	3.6
Meth+cys, g/kg	7.8	7.7	8.1	8.1	8.1	7.9
Threonine, g/kg	8.5	8.5	8.6	8.6	8.6	8.6
Valine, g/kg	10.1	9.7	10.2	9.8	10.1	9.7
Phytase activity, FTU[2]	1000	1498	1000	1383	1000	1290

[1] Average of 3 analyses

[2] Average of 2 batches. Group 4: 1583-1412 FTU. Group 5: 1337-1429 FTU. Group 6: 1276-1304 FTU.