LONG-TERM STUDIES OF REQUIREMENTS TO THE QUALITY OF RAPESEED MEAL FROM DOUBLE LOW VARIETIES USED IN SOW DIETS

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ABSTRACT

Experiments have been performed with two different types of double low rapeseed meal which have been included in sow diets at 10 and 20% levels, respectively, for a period of four years. The total amount of glucosinolates in the two types of rapeseed meal was 4 and 12 µmoles per g meal, and the content of aromatic choline esters was 28 and 23 µmoles per g meal, respectively. The rapeseed meals and diets were investigated by proximate analyses and amino acid composition, and for comparison, energy and N-balance trials with rats were performed. During the whole period, at appropriate and short intervals, the content of intact glucosinolates and aromatic choline esters in the diets were determined by HPLC.

The trials comprised 164 gilts divided into four groups, which were fed barley- and wheat-based diets with the following variations in the protein sources: (1) meat, bone, fish + soybean meal; (2) meat, bone, fish + 10% rapeseed meal; (3) soybean + 10% rapeseed meal; (4) 20% rapeseed meal. The animals were fed on the diets from an age of 6½ month till weaning of the fourth litter, i.e. a period of ca. 22 months.

The results did not reveal any differences in longevity and live weight gain of the sows in the four groups. The daily milk yield, chemical composition of the milk and farrowing intervals (160-164 days) were not significantly different for the four groups. Litter size of liveborn piglets averaged 10.8, 11.0, 11.0 and 10.4, respectively, for groups 1-4. Litter sizes at weaning (35 days of age) were correspondingly 9.7, 9.8, 9.9 and 9.1. Evaluation of taste samples from the loin muscle of the carcas did not show differences between the groups.

The best results were obtained with protein mixtures as used for groups 2 and 3. A trend towards smaller litter size was seen for group 4, especially when the rapeseed meal with the highest glucosinolate content was used, whereas no effects on other essential parameters were found.

INTRODUCTION

Rapeseed meal from double low varieties has attracted special attention as a possible high quality feeding stuff for pigs (Eggum et al., 1985a). The trials with double low rapeseed meal in diets to growing-finishing pigs have confirmed previously obtained results concerning the quality of rapeseed meal and antinutritional compounds therein (Bille et

al., 1983a;ibid 1983b). Optimal utilization of the high quality rapeseed meal with its well balanced amino acid composition and possible high biological value depends especially on the level of glucosinolates and degradation products thereof in the diets (Bjerg et al., 1986a; Eggum et al., 1985b).

Rapeseed meal with a high content of glucosinolates or their degradation products has a limited value as feed to pigs (Eggum et al., 1985a). A too high concentration of glucosinolates and/or their degradation products seems to be the main reason of the majority of antinutritional, quality and toxicological problems encountered in connection with utilization of rapeseed meal. The individual glucosinolates and products thereof give different degrees and types of antinutritional or toxic problems (Bille et al., 1983b; Bjerg et al., 1986b). This need to be considered as well as the importance of the quantitatively dominating glucosinolates occurring in double low varieties,e.g. 4-hydroxyglucobrassicin. The possibilities of their degradation during processing of rapeseed in the oil-mills, and the possibility that their degradation products can give even worse effects (Eggum et al., 1985c), need to be evaluated, and we need to use reliable methods of analysis (Bjerg et al., 1987a). The information now available have resulted in recommandations with respect to acceptable concentrations of glucosinolates in diets used to pigs (Bjerg et al., 1987b). It is, however, important to consider the possibilities of long-term effects from use of rapeseed meal in sow diets as discussed previously (Danielsen, 1985).

The present work is a continuation of the above mentioned studies and describes results from long-term studies of the effects from use of double low rapeseed meal in sow diets.

MATERIALS AND METHODS

The double low spring rape variety Brassica napus L cv. Line, grown in Denmark and processed to rapeseed meal at Aarhus Oil Factory, Denmark, was used in the first part of the experiments (1980 to May 1982). In the last part of the experiments was used rapeseed meal of unknown double low varieties processed of a German Oil Factory.

The trials comprised 164 gilt divided into four groups. Each group were fed their respective diets from 6½ month of age and during

four reproductive cycles, i.e. a period of 21-23 months. The composition of the diets are shown in Table 1.

Table 1. Formulation of diets used in long-term studies of the effects from use of double low rapeseed meal in sow diets.

	Group (Diet No.)			
	1	2	3	4
Barley %	38.8	37.5	36.1	34.7
Wheat %	38.8	37.5	36.1	34.7
Rapeseed meal %	0	10.0	10.0	20.0
Soybean meal %	7.0	0	7.0	0
Meat- and bone meal %	2.6	2.6	0	0
Fish meal %	2.6	2.6	0	0
Wheat bran %	8.0	8.0	8.0	8.0
Mineral mix	1.7	1.3	2.3	2.1
Vitamin mix	0.5	0.5	0.5	0.5

The N-balance trials and methods of analysis used for determination of the chemical compositions of the rapeseed meal and diets have been presented elsewhere (Bille et al., 1983a). The content of glucosinolates, aromatic choline esters and myrosinase activity in the rapeseed products and diets have been determined by recently developed methods (Bjerg and Sørensen, 1987c; Clausen et al., 1985; Buchwaldt et al., 1986).

The influences of the diets on the sows reproductive performance, growth and longevity were recorded. In addition influences on performance of their offspring were controlled until weaning at five weeks of age. By all 2nd and 3rd parity sows the daily milk yield was estimated on day 4, 11 and 18 of lactation. At farrowing and on day 12 of lactation milk samples were taken for analysis of dry matter and protein. At the end of the experiment a total of 28 sows allotted to either diet 1, 2, 3 or 4 were slaughtered. Meat samples from the loin muscle were taken for evaluation of colour and taste. Urine from the urinary bladder and content from different parts of the digestive tract were investigated for intact glucosinolates and aromatic choline esters.

RESULTS AND DISCUSSION

Table 2 shows results from the determinations (mean values) of the chemical composition of the diets and the rapeseed meal (1. period)

Table 2. Chemical composition (%DM) of the rapeseed meal in diets

	Rapeseed meal	Diet No. 1	2	3	4
Dry matter %	88.2	86.6	86.8	86.6	86.9
Protein (N x 6.25)	41.2	18.7	19.2	19.1	19.3
Stoldt fat	2.6	2.7	2.7	2.3	2.3
Crude fibre	13.9	4.6	5.4	5.9	6.7
Ash	7.8	5.2	5.3	5.2	5.3
Digestible energy (D.E.) MJ per kg DM	6.3	9.1	8.8	8.8	8.4

The amino acid composition for the rapeseed meal was nearly as previously described for other B. napus meal samples, and Table 3 shows results obtained in N-balance trials with rats (Bille et al., 1983).

Table 3. True protein digestibility (TD), biological value (BV) and net protein utilization (NPU) together with organ weights of rats fed diet No. 1-4 (Table 1).

	Diet No. 1	2	3	4
TD (%)	88.3	87.3	87.5	86.5
BV (%)	77.3	76.0	77.4	74.6
NPU (%)	68.2	66.3	67.7	64.5
Liver (mg/g rat)	35.6	35.3	33.1	35.1
Kidneys (mg/g rat)	8.6	9.0	8.7	9.3
Suprarenal glands (mg/g rat)	0.30	0.30	0.29	0.35
Thyroid (µg/g rat)	80	90	70	80

Table 4 shows results from determination of the individual glucosinolates in the rapeseed meal and diets. The content of glucosinolates was rather low in the rapeseed meal used in the first period. The rapeseed meal used in the last period has had a higher but still relatively low content of glucosinolates. Among the quantitatively dominating glucosinolates is 4-hydroxyglucobrassicin, but compared to the level normally found for this indolylglucosinolate in seed of double low varieties (Bjerg et al., 1987a), the level found in the meal and diets is quite low. This is also found generally for other types of rapeseed meal from double low varieties owing

to appreciable instability of this glucosinolate (Eggum et al., 1985c).

Table 4. Concentration (µmole/g) of glucosinolates in the rapeseed meal and diets

Glucosinolate (Bjerg et al., 1987a)	Rapeseed meal		Diets in 1.period		Diets in 2.period	
	1.period	2.period	No.2	No.4	No.2	No.4
Glucoraphanin	0.07	0.32	tr.	0.01	0.01	0.03
Glucoalyssin	0.10	0.64	-	-	0.02	0.06
Progoitrin	1.41	5.67	0.08	0.19	0.28	0.52
Napoleiferin	0.04	0.22	-	-	0.02	0.03
Gluconapin	0.83	2.08	0.06	0.12	0.11	0.46
Glucobrassicanapin	0.28	0.76	0.02	0.04	0.04	0.12
4-Hydroxyglucobrassicin	0.22	1.22	0.04	0.10	0.07	0.16
Glucobrassicin	0.04	0.08	tr.	0.01	tr.	0.01
4-Methoxyglucobrassicin	0.02	0.05	-	-	-	-
Other	0.55	1.20	0.04	0.11	0.06	0.70
Total	3.56	12.24	0.24	0.58	0.61	1.59

Figure 1 shows results from determination of glucosinolates and aromatic choline esters; about 80% was sinapine (Clausen et al. 1985).

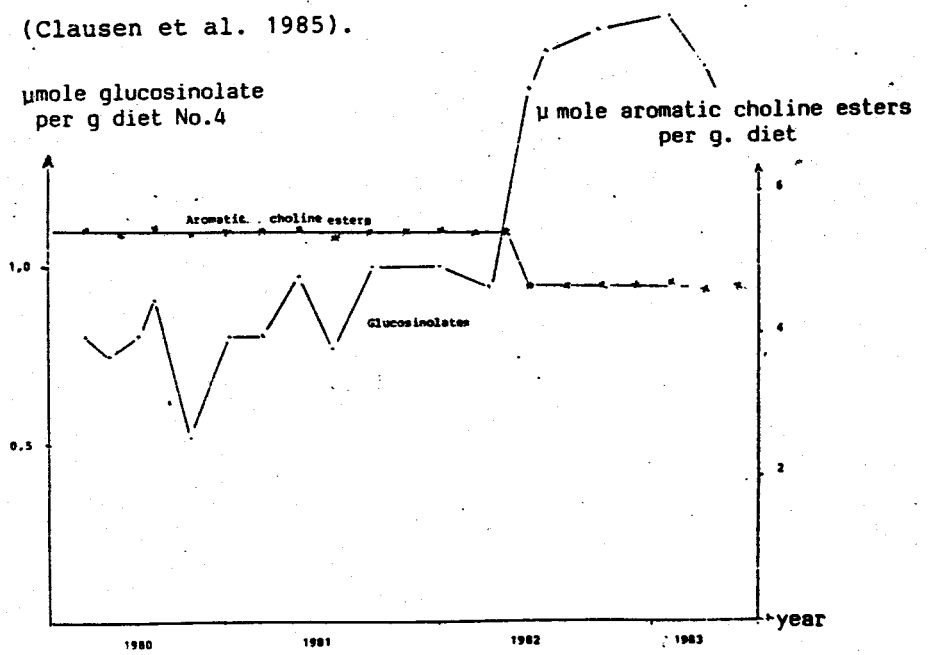

Figure 1. Concentration of total glucosinolate and aromatic choline ester content in diet No.4 during the experimental period.

Table 5 shows results obtained in the long-term studies of effects from different levels of double low rapeseed meal in sow diets.

Table 5. Results from the long-term studies of influences from double low rapeseed meal in sow diets on performance of sows and their offspring.

	Group No.			
	1	2	3	4
No. of gilts started	41	41	41	41
Total litters	136	135	140	139
Mean values for litter per sow	3.2	3.2	3.3	3.3
Farrowing interval in days (mean)	164	161	160	163
No. of litters per sow per year	2.23	2.27	2.28	2.24
Liveborn per litter (mean)	10.8	11.0	11.0	10.4
Weaned per litter (mean)	9.7	9.8	9.9	9.1
Birth weight, average per piglet (kg)	1.43	1.41	1.38	1.38
Weaning - - - pig (kg)	8.5	8.5	8.4	8.6
Daily milk yield of sows (mean; kg)	7.4	7.4	7.6	7.0

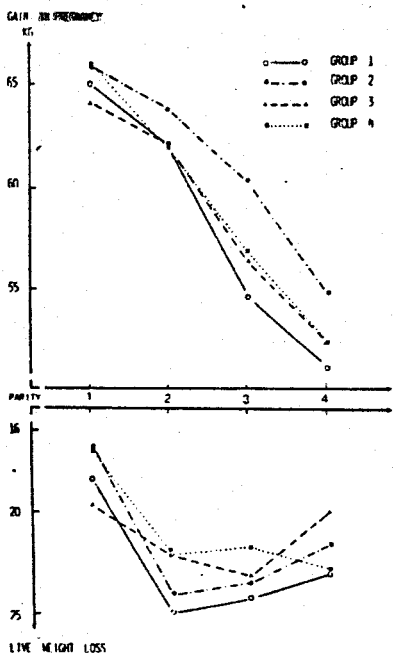

Figure 2. Sows live weight gain during pregnancy and weight loss in lactation in four parities.

Evaluation of colour and taste of meat from sows included in the present experiment showed no detrimental effects on meat quality from any of the diets. Neither of the other

investigated results have been appreciable changed as a result of the different diets. With a quality of the rapeseed meal as the meal used in especially the first period 10 per cent rapeseedmeal can be used as replacement of either soybean meal or animal protein supplement without depreciation of any of the results. By application of 20 per cent rapeseed meal of the described quality in sow diets, a negative trend is seen on littersize, which seems to be a result of especially the rapeseed meal quality used in the last period. The results obtained with diets No. 2 and 3 seem to be slightly better than for diets No. 1 and 4, although not significantly different.

REFERENCES

1. Eggum, B.O., Just, A. and Sørensen, H.(1985a): Double low rapeseed meal in diets to growing - finishing pigs. In: Advances in the Production and Utilization of Cruciferous Crops. (Ed. Sørensen, H.) Martinus Nijhoff/Dr. W. Junk Publ., Dordrecht/Boston/Lancaster. pp.167.176.
2. Bille, N., Eggum, B.O., Jacobsen, I., Olasen, O. and Sørensen, H. (1983a): The effects of processing on antinutritional rape constituents and the nutritive value of double low rapeseed meal. Zeitschr. Tierphysiol., Tierernährung u. Futtermittelkd. 40, 148-163.
3. Bille, N., Eggum, B.O., Jacobsen, I., Olsen, O. and Sørensen, H. (1983b) Antinutritional and toxic effects in rats of individual glucosinolate (±myrosinases) added to a standard diet. 1. The effects on protein utilization and organ weights. ibid. pp. 195-210.
4. Bjerg, B., Eggum, B.O., Jacobsen, I., Larsen, L.M., Rahman, M.H. and Sørensen, H. (1986a): Ernæringsmæssig kvalitet af mørkskallet dobbeltlav vårraps (Topas) og af gulskallet raps i relation til glucosinolatindhold, tannin og procesbehandling. Statens Husdyrbrugsforsøg, Meddelelse nr. 634, 1-4.
5. Eggum, B.O., Larsen, L.M., Poulsen, M.H. and Sørensen (1985b): Conclusions and recommendatioons. In: Advances in the Production and Utilization of Cruciferous Crops. (Ed. Sørensen, H.) Martinus Nijhoff/Dr. W. Junk. Publ., Dordrecht/Boston/Lancaster. pp. 304-311.
6. Bjerg, B., Eggum, B.O., Jacobsen, I., Jensen, J., Larsen, L.M. and Sørensen, H. (1986b): Ernæringsmæssige og toksiske effekter af seks individuelle glucosinolater iblandet en glucosinolatfri diæt og fodret til rotter. Statens Husdyrbrugsforsøg, Meddelelse nr. 619, 1-4.
7. Eggum, B.O., Olsen, O. and Sørensen, H. (1985c): Effects of glucosinolates on the nutritive value of rapeseed. In: Advances in the Production and Utilization of Cruciferous Crops. (Ed. Sørensen, H.) Martinus Nijhoff/Dr. W. Junk Publ., Dordrecht/Boston/Lancaster. pp. 50-60.
8. Bjerg, B., Larsen, L.M. and Sørensen, H. (1987a): Reliability of analytical methods for quantitative determination of individual glucosinolates and total glucosinolate content in double low oilseed rape. Contribution to: 7th International Rapeseed Congress, Poznan, Poland, in prep.

9. Bjerg, B., Eggum, B.O., Larsen, L.M. and Sørensen, H. (1987b): Acceptable concentrations of glucosinolates in double low oilseed rape and possibilities of further quality improvements by processing and plant breeding. Contribution to: 7th International Rapeseed Congress, Poznan, Poland. in prep.
10. Danielsen, V. (1985): The long term influence of rape seed meal in sow diets. In: Advances in the Production and Utilization of Cruciferous Crops. (Ed. Sørensen, H.) Martinus Nijhoff/Dr. W. Junk Publ., Dordrecht /Boston/Lancaster. pp. 199-207.
11. Bjerg, B. and Sørensen, H. (1987c): Quantitative analysis of glucosinolates in oilseed rape based on HPLC of desulfoglucosinolates and HPLC of intact glucosinolates. In: Proceedings from CEC Workshop, Glucosinolates in Rapeseeds, Analytical Aspects, October 1986 in Gembloux, Belgium. in press.
12. Clausen, S., Larsen , L.M., Plöger, A. and Sørensen, H. (1985): Aromatic choline esters in rape seed. In: Advances in the Production and Utilization of Cruciferous Crops (Ed. Sørensen, H.) Martinus Nijhoff/ Dr. W. Junk Publ., Dordrecht/Boston/Lancaster. pp. 61-72.
13. Buchwaldt, L., Larsen, L.M., Plöger, A. and Sørensen, H. (1986): FPLC isolation and characterization of plant myrosinase, ß-thioglucoside glucohydrolase, isoenzymes.
J. Chromatogr. 363(1), 71-80.