THE USE OF WHOLE RAPESEED IN YOUNG PIG DIETS

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INTRODUCTION

Whole rapeseed is potentially a useful high-energy protein source for young pigs. Milled with cereals, it could provide a convenient method for adding fat and some good quality protein to on-farm produced diets, avoiding the need for premixes and the disadvantages of handling extracted vegetable oils. Until recently, the addition of rapeseed and rapeseed meals to young pig diets has not been possible due to high glucosinolate content (Bell 1984). These are naturally occurring plant compounds which release goitrogenic and toxic factors following hydrolysis, in the seed or the animal, by the enzyme myrosinase. Glucosinolate content has been reduced by plant breeders in improved varieties and commercial EC rapeseed production is guaranteed a premium if this does not exceed 35 µmoles/g whole seed. This has renewed interest in the use of rapeseed in pig diets.

The aim of this study was to examine the opportunity for using whole rapeseed, from improved varieties, as a dietary energy and protein supplement for weaned and young pigs.

MATERIALS AND METHODS

In experiment 1, 120 Large White x (Large White x Landrace) piglets were weaned between 3 and 4 weeks of age (7.41 kg, s.e.m. 0.100) in 4 blocks of 30 each. Each block was divided into 3 contemporary groups of 10 piglets, balanced for initial weight, sex (entire males and females) and origin of litter. Each group was allocated to one of three experimental diets (Table 1). Low-glucosinolate full-fat rapeseed meal (LGFFR; *Brassica napus*, var. Ariana) was used at two different inclusion rates (200 and 400 g/kg) to replace full-fat soyabean meal (FFS) in a control diet. All diets were formulated to provide 16g total lysine/kg and 17.5 MJ digestible energy (DE)/kg using book values for raw ingredients. Adjustments in DE and lysine were made by the use of soya oil and lysine hydrochloride.

Piglets were housed as groups in fully insulated flat-deck pens. A commercial diet was offered *ad libitum* for 1 week after weaning followed by *ad libitum* feeding of experimental diets for 3 weeks. Piglets were individually weighed and residual feed was weighed weekly. Water was supplied from nipple drinkers.

Table 1. Formulation and proximate analyses of diets (Experiment 1)

Diet	1 (Control)	2	3
Ingredients (g/kg)			
Full-fat rapeseed meal	0	200	400
Full-fat soyabean meal	200	100	0
Dried skim milk	100	100	100
White-fish meal	72.1	79.5	86.8
Oat flakes	100	100	100
Maize flakes	100	100	100
Wheat flakes	273.9	214.3	154.9
Soyabean oil	88.1	44.1	0
Dried whey	50	50	50
Lysine HCl	3.9	4.1	4.3
Salt	2	2	2
Dicalcium phosphate	8	4	0
Mineral and vitamin mix	2	2	2
Proximate analyses (g/kg)			
Dry matter	921	921	925
Crude protein	192	187	185
Crude fibre	15	61	99
Ether extract	97	156	179
Ash	57	55	54
DE (1) (MJ/kg)	15.1	15.3	15.2

(1) Estimated from proximate constituents using regression equation (E.E.A.P. Working Group:Provisional equation; Batterham 1990)

In experiment 2, 180 Large White x (Large White x Landrace) pigs, averaging 18.2kg (s.e.m. 0.34), were received in 6 blocks of 30 each. Each block was divided into 5 contemporary groups of 6, balanced for initial weight, sex (entire males and females) and origin of litter. Each group was allocated to one of five experimental diets (Table 2). LGFFR of either *B. napus* (var. Topas) or *B. campestris* (var. unnamed) was used at two different inclusion rates (125 or 250g/kg) to replace soyabean meal and soyabean oil in the control diet. All diets were formulated to provide 10g apparent ileally digestible lysine per kg and 15.4 MJ DE/kg using published information and book values for raw ingredients (Sauer *et al.* 1982; Rowan and Lawrence 1986; Partridge *et al.* 1987; NRC 1988).

Pigs were housed as groups in insulated growing accommodation with fully-slatted pens. The experimental diets were pelleted and offered *ad libitum* from hoppers. Pigs were weighed individually on two consecutive days at the beginning and end of the experiment. Residual feed was removed and weighed at the end. Water was available from bite drinkers.

Analysis of Rapeseeds

Table 3 gives results of standard proximate analyses and total glucosinolate contents as determined by the glucose release method of Van Etten *et al.* (1974). Rapeseeds used in experiment 2 were assayed for individual glucosinolates by high-performance liquid chromatography (HPLC) using published techniques (Sang *et al.* 1984; Spinks *et al.* 1984). Results of HPLC analyses are presented in Table 4.

Table 2. Formulation and proximate analyses of diets (Experiment 2)

Diet	1 (Control)	2 125gLGFFR/kg	3	4 250gLGFFR/kg	5
Ingredients (g/kg)					
Barley	605.4	555.7	557.4	504.6	509.5
White-fish meal	75.0	75.0	75.0	75.0	75.0
Soyabean meal	213.7	183.3	179.3	153.0	144.9
Full-fat rapeseed meal					
B. napus	-	125.0	-	250.0	-
B. campestris	-	-	125.0	-	250.0
Soyabean oil	84.8	41.7	43.9	-	3.0
Dicalcium phosphate	9.7	7.9	8.0	6.0	6.2
Limestone	4.7	4.7	4.7	4.8	4.7
Salt	4.2	4.2	4.2	4.2	4.2
Mineral and vitamin mix	2.5	2.5	2.5	2.5	2.5
Proximate analyses (g/kg)					
Dry matter	902.2	897.3	899.9	898.9	901.5
Crude protein	217.2	215.6	215.8	214.6	213.3
Crude fibre	34.3	39.5	42.7	39.4	45.9
Ether extract	99.0	113.7	116.5	129.9	127.4
Ash	59.3	59.8	60.1	59.0	60.3
DE [(1)] (MJ/kg)	15.6	15.5	15.5	15.7	15.5

(1) Estimated from proximate constituents using regression equation (Morgan *et al.* 1987).

Table 3. Proximate constituents and total glucosinolate content of rapeseeds fed to weaned and young pigs

	Experiment 1	Experiment 2	
	B. napus (var. Ariana)	*B. napus* (var. Topas)	*B. camperstris* (var. unnamed)
Proximate analyses (g/kg)			
Dry matter	929.0	919.4	917.0
Crude protein	198.4	186.1	206.6
Crude fibre	58.3	78.0	76.1
Ether extract	384.1	423.7	413.8
Ash	45.0	39.7	44.6
Total glucosinolates (μmoles/g)	17.0	7.7	4.6

Table 4. Individual glucosinolates (μmoles/g whole seed) in rapeseed fed to young pigs (Experiment 2)

	B. napus (var. Topas)	*B. campestris* (var. unnamed)
Glucosinolate		
Glunconapin	2.06	1.56
Glucobrassicanapin	0.77	0.94
Progoitrin	5.53	2.61
Gluconapoleiferin	0.70	0.84
Gluconasturtiin & 4-Methoxyglucobrassicin	0.11	0.14
4-Hydroxyglucobrassicin	0.31	ND[(1)]
Glucobrassicin	0.09	ND
Total glucosinolates (HPLC)	9.57	6.09

(1) Not detected

Statistical Analysis

Data from both experiments were treated as Randomised Complete Block Designs and subjected to Analysis of Variance (Snedecor and Cochran 1967).

RESULTS

Experiment 1. Intakes, daily gains and feed conversion efficiencies of piglets according to dietary treatment are presented in Table 5. Partial and complete replacement of FFS and soyabean oil with LGFFR significantly reduced intake ($P<0.005$) and daily gain ($P<0.001$). The conversion of feed to gain was significantly poorer ($P<0.05$) on diets containing LGFFR. Piglets offered LGFFR diets had lighter ($P<0.001$) body weights at the end of the 4 week trial period. Differences in intake, gain and feed conversion on the two dietary inclusion rates of LGFFR were not significant ($P>0.05$).

Table 5. Voluntary intake, growth rate and conversion of feed to gain by weaned piglets according to dietary treatment[1] (Experiment 1)

Diet	1 (Control)	2	3	s.e.d.[2]
Initial weight (kg) [3]	8.46	8.35	8.43	0.283
Final weight (kg)	16.35[a]	13.07[b]	12.50[b]	0.436
Daily feed intake (kg)	0.52[a]	0.38[b]	0.34[b]	0.027
Daily weight gain (kg)	0.40[a]	0.24[b]	0.20[b]	0.019
Food conversion (intake/gain)	1.30[a]	1.59[b]	1.66[b]	0.120

(a,b,c,) Means in the same row with a common superscript do not differ significantly ($P>0.05$).
(1) After Gill (1989).
(2) Standard error of the difference between means (6 d.f.).
(3) One week after weaning.

Experiment 2 Daily intakes, gains and feed conversion of pigs on each dietary treatment are presented in Table 6. Effects of variety and dietary inclusion rate of LGFFR are compared in Table 7. With the exception of reduced final weights on diets containing 250g LGFFR/kg ($P<0.02$), there were no significant ($P>0.05$) treatment, LGFFR variety or inclusion rate effects on pig performance.

Table 6. Voluntary intake, growth rate and conversion of feed to gain by young pigs according to dietary treatment (Experiment 2)

Diet	1 (Control)	2	3	4	5	s.e.d.
		125gLGFFR/kg		250gLGFFR/kg		
Initial weight (kg)	17.71	17.74	18.62	18.60	18.28	1.109
Final weight (kg)	49.69	49.65	49.46	47.45	45.89	1.488
Daily feed intake (kg)	1:52	1.52	1.45	1.61	1.60	0.170
Daily weight gain (kg)	0.66	0.66	0.65	0.64	0.61	0.034
Feed conversion	2.31	2.33	2.26	2.57	2.63	0.253

Table 7. Effect of LGFFR variety and inclusion rate on performance of young pigs (Experiment 2)

	variety		Inclusion rate (g/kg)		
	Topas (*B. napus*)	Unnamed (*B. campestris*)	125	250	s.e.d.
Initial weight (kg)	18.17	18.47	18.18	18.45	0.736
Final weight (kg)	48.55	47.84	49.56	46.74	0.335
Daily feed intake (kg)	1.57	1.52	1.49	1.61	0.116
Daily weight gain (kg)	0.65	0.63	0.65	0.63	0.026
Feed conversion	2.45	2.43	2.30	2.59	0.174

DISCUSSION

The experiments described in this study indicate that age is an important consideration for the inclusion of whole milled rapeseed in the diets of young pigs. Because the experiments used different sources of rapeseed it is not possible to completely evaluate the interaction between age, rapeseed inclusion rate and glucosinolate level. However, a number of observations deserve comment. Experiment 1 demonstrated that baby pigs, weaned at around 3 weeks of age, are particularly sensitive to rapeseed in their diets. There was an immediate response with reductions in intake and weight gain found in the first week on rapeseed diets. The effect was similar at both LGFFR inclusion rates, suggesting that additional glucosinolate intake is not significant once a critical level of intake has been reached. This level is probably below the minimum intake of 75.4 µmoles/kg body weight per day as calculated for diet 2, since baby pigs have been shown to reject diets containing as little as 5% extracted Canola meal (Baidoo et al. 1986).

With weaned piglets the effects of rapeseed were cumulative. Relative to the control, voluntary intakes of diets containing LGFFR were depressed by 19.7, 29.2 and 37.4% during weeks 2, 3 and 4 respectively. Differences in body weight also increased with time, by the end of weeks 2, 3 and 4 pigs fed LGFFR diets were 13.3, 17.9 and 22.0% lighter than those fed the control.

The results of experiment 2 suggest that low-glucosinolate rapeseed can be fed to young pigs using up to 250g LGFFR/kg without significant effects on intake and performance. The apparent lack of rapeseed toxicity could be a function of age and glucosinolate intake per unit of body weight. Compared with experiment 1, these animals were twice the average age and three times the average weight with estimated glucosinolate intake not exceeding 93.9 µmoles/kg body weight per day. Gut maturity, internal organ development, thyroid function and immunity could be important factors in the tolerance to rapeseed in older pigs, but these require investigation.

CONCLUSIONS

At present, the use of whole rapeseed in piglet diets should be restricted to animals which have been established beyond the post-weaning stage. Rapeseed, with glucosinolate contents of 17 µmoles/g and over, cannot be safely fed to piglets weaned at 3 weeks of age without adversely effecting appetite and growth rate and loss of health which may compromise their welfare.

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