A COMPARISON OF RAPE SEED MEAL AND SUNFLOWER SEED MEAL IN THE DIET OF THE DAIRY COW

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Solvent-extracted rape seed meal is readily available and competitively priced in the U.K. Market but fears of unpalatability and toxicity place severe restrictions on the amount incorporated into dairy cow rations. Two experiments were carried out to compare rape seed meal with sunflower seed meal as components of either a complete diet given ad libitum or concentrate feeds given in amounts rationed according to yield. The experiments were designed to give an indication of protein value under protein limiting conditions and of possible toxicity under high levels of inclusion. Since protein requirements of ruminants have not been clearly defined (Miller, Balch, Roy, Ørskov & Smith, 1977) the experiments were designed to determine the response to increments of protein so as to indicate the optimum range of protein inclusion.

In the first experiment there were six complete diets based on (g/kg) rolled barley 380, milled barley straw 350, with either sunflower seed meal (SFM) 50, 100 or 150 or rape seed meal (RSM) 50, 100 or 150 replacing a mixture of ground barley and barley straw such that estimated metabolisable energy and crude fibre were maintained constant. Twelve Friesian cows were each given the six diets for 4 week periods during the 6th to 29th week of lactation. The sequence of diets was according to pairs of 3 x 3 Latin squares balanced for residual effects. Within each Latin Square, the three diets consisted of the three levels of either SFM or RSM. The RSM was processed from a single shipment of seed of Swedish origin and found on microscopic examination to contain 50% B. napus and 50% B. campestris. The meal contained 3.1 mg/g bound isothiocyanate and 3.9 mg/g bound oxazolidinethione but no free goitrogens were detected. Direct effects of treatments on milk yield and composition were determined from data of the 3rd and 4th week of each period. Residual effects were determined by examination of data of the 1st and 2nd weeks of the succeeding period. Cows were fitted with bladder catheters for the final 3 days of each period to determine N balance. Jugular blood was obtained in the final week every three hours over two 12 h periods.

The experimental design allowed a direct comparison of the mean of three cows receiving SFM with three cows receiving RSM replicated four times. In no case were differences significant, but the test is not precise because of the few degrees of freedom (4). Comparison of the three levels of either SFM or RSM is made on a within cow basis. The mean values are shown in Table 1 together with the standard errors of a mean which are appropriate for comparisons between levels of inclusion within a protein type.

Dry matter intake and milk yield increased linearly ($P < 0.05$) with increase in SFM but not with RSM. There was no significant effect on either milk fat or solids not fat percentage. Therefore, solids corrected milk yield followed similar trends to those for milk yield, but differences were smaller and the variance greater so that statistical significance was not achieved. Whereas increasing SFM level had a small positive residual effect on milk yield in the succeeding period, the higher levels of RSM had marked negative residual effects. Following 100 g/kg RSM as compared to 50 g/kg, milk yield was depressed and butter fat % was increased ($P < 0.05$). Following 150 g/kg RSM the depression in milk yield was not quite significant in the first two weeks, but became even more marked and achieved significance (P < 0.05) in the second two weeks of the succeeding period.

Organic matter digestibility was significantly greater (P < 0.05) for the intermediate level of both SFM and RSM. Nitrogen digestibility increased for both SFM and RSM with increase in level from 50 to 100 g/kg. Further increases in either protein resulted in little change.

Table 1.

Experiment 1. Effect of sunflower or rape seed meal in complete diets for dairy cows over 6 - 29th week of lactation.

	Sunflower			Rape seed			SEM+
Test inclusion (g/kg)	50	100	150	50	100	150	
Crude protein (g/kg DM)	94	111	128	94	112	131	-
Dry matter intake (kg/d)	16.1	16.8	17.8	16.0	16.3	16.0	0.55
Milk yield (kg/d)	14.8	15.2	15.9	15.1	15.0	15.5	0.35
SCM* yield (kg/d)	14.3	15.0	15.1	14.5	14.4	14.8	0.40
Butterfat (%)	3.9	3.9	3.8	3.8	3.9	3.8	0.12
Solids not fat (%)	8.7	8.9	8.8	8.5	8.6	8.7	0.10
Digestibility: (%)							
Organic matter	57.2	60.8	56.1	60.0	64.4	61.3	1.42
Nitrogen	38.1	51.6	50.2	44.6	53.6	55.8	1.45
N balance: (g/d)							
Milk N	63.6	74.6	74.5	67.6	69.1	64.2	4.04
Retained N	-26.2	-8.9	16.3	-15.5	16.1	21.8	10.73
Milk + retained N	35.2	68.0	87.8	52.6	83.1	85.9	9.67
Plasma urea (mmol/l)	2.42	3.34	4.65	1.92	3.01	3.85	0.258
Residual effects:							
Milk yield (kg/d)	14.8	15.0	15.1	15.1	13.3	13.6	0.60
SCM* yield (kg/d)	14.3	14.2	14.5	14.1	13.1	12.8	0.61
Butterfat (%)	3.7	3.8	3.9	3.6	4.0	3.6	0.14

*SCM Solids-corrected milk yield. +Standard error of a mean.

In the 3 day N balance trials, 100 g/kg SFM gave the highest milk N secretion/d whereas increasing levels of RSM gave no increase. The cows were in negative nitrogen balance on the 50 g/kg of both sunflower and rape seed meal. Body N change increased linearly ($P \leq 0.05$) with level of both proteins. Plasma urea concentration also increased linearly ($P < 0.001$).

In a second experiment, 10 Friesian cows were each given 5 kg hay and 1.7 kg rolled barley per day and, in turn, five concentrate mixes at the rate of 0.46 kg/kg milk yield according to two 5 x 5 Latin Squares balanced for residual effects. Periods were of 28 d between the 6th and 25th week of lactation. Rate of concentrate feeding was adjusted at the beginning of each period, then maintained for the succeeding 28 d. Concentrates were given twice daily. The five concentrates consisted of a basal diet of rolled barley (g/kg) 872, Molassine meal 50, fat 30, urea 10, mineral and vitamin premixes 38 or with SFM 100 or 200, or RSM 100 or 200 replacing mainly barley together with a small adjustment in limestone flour and dicalcium phosphate to maintain Ca and P levels constant. The rape seed meal was a different batch of similar origin, botanical and chemical composition to that used in the first trial.

Concentrate intake, which was based on the milk yield over the two weeks immediately preceding each period, did not differ significantly with treatment, although the basal diet did receive the smallest amount (Table 2). Compared with the basal diet milk yield was increased by inclusion of 100 g/kg of protein concentrate ($P < 0.05$), but the increase with 200 g/kg was less and not significant. Butter fat was increased by 200 g/kg SFM but not by RSM ($P < 0.05$). There were no differences in solids not fat content. Consequently similar solids-corrected milk yields were achieved by SFM at 100 and 200 g/kg and by RSM at 100 g/kg. Only the latter was significantly greater ($P < 0.05$) than the basal diet. Plasma urea increased linearly with inclusion of SFM but with RSM there was a large increase with the first level and no further increase with the higher level. There were significant residual effects on butter fat percentage and liveweight change. Butter fat percentage increased following 200 g/kg SFM compared with the basal and liveweight gain increased linearly with protein level in the preceding period.

Table 2.

Experiment 2. Effect of sunflower or rape seed meal in concentrates given in rationed amounts to dairy cows over 6th - 25th week of lactation.

	Basal	Sunflower		Rape seed		
Test inclusion (g/kg)	0	100	200	100	200	SEM+
Crude protein (g/kg DM)	142	169	196	171	200	
Concentrate intake (kg/d)	9.95	10.19	10.13	10.30	10.05	0.173
Milk yield (kg/d)	19.4	20.5	19.7	20.8	19.9	0.42
SCM* yield (kg/d)	16.4	17.3	17.6	18.2	17.0	0.53
Butterfat (%)	2.96	3.14	3.36	3.10	2.95	0.139
Solids not fat (%)	8.68	8.74	8.82	8.83	8.88	0.121
Plasma urea (mmol/l)	4.38	5.64	6.95	6.38	6.19	0.252

*SCM Solids-corrected milk yield. +SEM Standard error of a mean.

In these two experiments cows have consumed very large amounts of RSM, especially in early lactation, without marked physiological upsets or obvious inappetance. In the first experiment there may have been some reduction in voluntary intake at the highest level of inclusion compared with sunflower since there was no increase in intake with level of RSM. In the second experiment where concentrates were offered twice daily, the allocation was readily consumed and, except for a few occasions at peak yield, was cleared within 15 minutes. However the lack of response in milk or solids corrected milk yield to increased RSM in experiment 1 and to the higher level of RSM in experiment 2, and the residual effect of high levels of RSM on subsequent milk yield in experiment 1 suggest the presence of a toxic factor influencing milk synthesis. The N balance trial also indicated a lower milk N secretion but there was no impairment in the ability of the cow to store surplus nitrogen.

Recent proposals for methods of calculating the protein needs of ruminants (Roy, Balch, Miller, Ørskov & Smith, 1977) stress the need to consider the requirements of the rumen micro-organisms for degradable protein and the requirements of the tissues for amino acids absorbed from the small intestine. In experiment 1, the low plasma urea values when the basal diets were fed, together with the increase in digestibility of organic matter with the intermediate level of protein concentrate, suggest the basal diets contained inadequate degradable protein for optimal microbial growth and digestion of the feed. If this is so, then the value of the protein at the low level of inclusion in these diets (50 g/kg) will be proportional to the relative rates and extent of degradability in the rumen. In separate studies RSM has been found to be more soluble in buffer solutions and to disappear more rapidly from polyester bags suspended in the rumen of sheep than SFM (Mathers, Morton & Miller, 1977). Therefore, at the 50 g/kg level, RSM might be expected to be better than SFM. The digestibility and milk yield data support this hypothesis. Inclusion of 100 g/kg of the protein concentrates would not only correct the deficiency of degradable protein for the rumen microorganisms but would also contribute additional amino acids for absorption from the small intestine. For this purpose SFM might be expected to be superior to RSM on account of the postulated lower degradability in the rumen and better methionine content. The data at the intermediate level of protein inclusion is in concordance with this hypothesis, although the possibility of any inhibiting factor in the rapeseed meal exerting an effect cannot be ruled out. From experiment 1, the optimum crude protein content of the complete diet appears to be in the region of 111-112 g/kg dry matter for both SFM and RSM to meet the average yield of 15 kg milk. This is in good agreement with predictions based on the new ARC proposals (Miller et al, 1977). However, in the first three periods of the lactation, milk yields on the SFM diets increased with protein level from 18.4 to 20.1 kg and the optimum is probably nearer to 128 g/kg dry matter for these higher milk yields.

In experiment 2, urea in the concentrates would provide at least part of the requirement of the rumen micro-organism. however, because the concentrates were given twice daily, there may still have been periods when nitrogen could be limiting in the rumen of cows fed the basal diet. As in the previous experiment the intermediate level of either protein source appeared to be the optimum for milk production. In the complete diet, averaged over the whole period of the experiment, this level provided approximately 149 g crude protein/kg dry matter and supported an average solids corrected milk yield of 17 to 18 kg/d.

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