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NEW DEVELOPMENTS CONCERNING NUTRITIONAL CHARACTERISTICS OF RAPESEED MEAL

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It is the objective of this report to present the major results of several studies that have been conducted or are under way. One deals with rapeseed meal prepared from a "zero erucic acid" variety of rapeseed from which "Canbra" oil is produced and which is likely to assume greater commercial significance in the years ahead. Results will be presented on the nutritional evaluation of a low-glucosinolate variety of rapeseed, namely Bronowski. Finally some comments will be made on the economic aspects of rapeseed meal and of 'improved' rapeseed meal as it relates to computer formulation by the feed trade.

It will be apparent that these studies pertain to the eventual production of rapeseed which will yield rapeseed meal virtually free of glucosinolates, which will have a higher digestible energy and digestible protein content and which may under some circumstances at least come from seed containing low levels of erucic acid.

COMPARISONS OF BRASSICA NAPUS, B. CAMPESTRIS AND B. NAPUS "ZERO ERUCIC" RAPESEED MEALS

A growth and feed utilization study involving 120 pigs over the weight range 23-50 kg (50-110 lb) and fed rations containing 5 different protein supplements was conducted. The protein sources were solvent processed soybean meal, B. campestris (solvent-processed), B. campestris (solvent processed, with gums added), B. napus (pre-press solvent extracted) and B. napus, "zero erucic" type, solvent processed. The protein and glucosinolate contents of the rapeseed meals are shown in Table I.

The pigs were fed a ration based on wheat and barley as outlined in Table II and a soybean meal control ration was also included. The soybean ration involved replacing the rapeseed meal component with 80% as much soybean meal and allocating the weight difference equally to wheat and barley. The rapeseed meal rations analyzed 16.0 to 16.5% protein (air-dry basis) and the soybean meal ration contained 17.6% protein.

TABLE I

CHEMICAL COMPOSITION OF THE RAPESEED MEALS USED IN THE SWINE RATIONS (DRY MATTER BASIS)

Meal	Protein (N x 6.25)	Butenyl Isothio-cyanate	Pentenyl Isothio-cyanate	Oxazolidine-thione
	%	mg aglucone/gm		
B. campestris	42.3	2.4	1.5	4.3
B. campestris, + gums, pelleted	34.2	1.9	1.4	1.7
B. napus, pre-press solvent extr.	38.6	2.0	0.7	8.3
B. napus, "zero erucic", solvent extr.	39.8	1.6	0.3	6.9

TABLE II

FORMULAS OF RATIONS FOR PIGS FED RAPESEED MEAL RATIONS

Ingredient	Amount per 1000 lb	Amount per 1000 kg
Wheat	407 lb	895 lb
Barley	407 lb	895 lb
Fishmeal, herring	10 lb	22 lb
Rapeseed meal	150 lb	330 lb
Dicalcium phosphate	13.4 lb	29.5 lb
Calcium carbonate	5.3 lb	11.7 lb
Dl-methionine	1.0 lb	2.2 lb
Salt, iodized	5.0 lb	11.0 lb
Riboflavin	660 mg	1.45gm
Pantothenic acid	705 mg	1.55gm
Vitamin A (x 1000)	650 I.U.	1,430 I.U.
Vitamin D (x 1000)	200 I.U.	440 I.U.
Vitamin B_{12}	5.5 mg	12 mg
ZnO	20 gm	44 gm
Oxytetracycline	6.3 gm	14 gm

The results of the feeding trial (Table III, Fig. I) revealed no differences (P = .05) between any of the rapeseed meal sources but pigs fed soybean meal rations gained slightly better. Efficiency of feed utilization showed no significant differences between rapeseed meals and soybean meal rations.

No digestibility studies were made in this experiment but it is probable, with soybean meal averaging 10-11% higher in digestible energy content than rapeseed meal and with more wheat being involved in the soybean meal rations, that the soybean rations contained more digestible and metabolizable energy than did the rapeseed meal rations. This could well have accounted for some if not all of the difference in rate of gain in favor of soybean meal rations.

TABLE III

GROWTH AND FEED UTILIZATION RESPONSES

Ration	Ave. Daily Gain	Ave. Feed Per Kg Gain
	gm	kg
B. campestris	531	3.23
B. campestris, + gums, pelleted	522	3.04
B. napus	535	2.97
B. napus, "zero erucic"	522	3.28
Soybean	585	2.95

The results of this experiment indicate no significant differences between four different types of rapeseed meal as used in swine rations. It is also evident that without adjusting rations to isocaloric conditions the use of 15% rapeseed meal will permit at least 90% of the growth rate obtainable on soybean meal supplemented rations with about the same efficiency of feed conversion.

NUTRITIONAL EVALUATION OF A LOW GLUCOSINOLATE RAPE[illegible] USING MICE

Bronowski rapeseed meal (solvent extracted and myr[illegible] free), a B. napus variety, contains very little gl[illegible] The sample available for these experiments contain[illegible] mg 3-butenyl and 0.03 mg of 4-pentenyl isothiocyana[illegible] mg oxazolidinethione per gram of dry matter. These [illegible] compared with 2.40, 0.70 and 10.40 mg/gm respective[illegible] B. napus variety also included in the test.

The various meals were incorporated at levels of [illegible] of the diet and were tested with and without a fl[illegible] mixture, with and without supplementary myrosinase.

The complete report is being published elsewhere [illegible] findings of interest to this conference are presen[illegible] Table IV. It is observed that the Bronowski varie[illegible] favorably with other rapeseed meals and with soybe[illegible] regard to digestibility of protein and energy in t[illegible] The weight gains are the average responses obtained [illegible] 10 and 20% meal levels. It is obvious that the mic[illegible] Bronowski meal gained as well as those fed soybean [illegible] better than those fed other varieties of rapeseed [illegible]

TABLE IV

DIGESTIBILITY, GROWTH AND FEED UTILIZATION [illegible] OF MICE FED DIFFERENT KINDS OF RAPESEED [illegible]

Protein Source	DIGESTIBILITY		WEI[illegible]	
	Protein	Energy	Observe[illegible]	[illegible]
	%	%	gm	[illegible]
B. napus				
Nugget variety	85	84	9.9	[illegible]
Bronowski variety	81	84	11.7	[illegible]
B. campestris				
Echo variety	82	84	9.7	[illegible]
Soybean meal control	82	84	11.7	[illegible]

& - Adjusted by regression to average digestible [illegible]

For various reasons, animals do not always eat the [illegible] of feed. Consequently the question often arises [illegible]

gains reflect intake levels or quality of the diet. Palatability has been recognized as a problem in feeding rapeseed meal and it was found in this experiment that there was a high correlation between feed intakes (in terms of digestible energy, DE) and rate of gain. Subsequent adjustment of gains to the average DE intake resulted in a reduction in the gain obtained with mice fed Bronowski meal whereas the reverse was true with mice fed other varieties of rapeseed meal. Thus, above-average feed intakes were obtained with Bronowski rapeseed meal and soybean meal. The energy-adjusted gains were similar for all diets.

It is concluded from this study that glucosinolate-low or free rapeseed meals can be expected to incur few if any problems associated with palatability and could be recommended for practical feeding without restrictions related to glucosinolate contents.

COMPARISONS OF BRONOWSKI RAPESEED MEAL WITH TYPICAL COMMERCIAL RAPESEED MEALS

GROWING PIGS

A supply of Bronowski (B. napus, low glucosinolate) rapeseed was grown in Saskatchewan from imported seed from Poland and converted to solvent-processed meal for feeding trials. The seed that was extracted was judged to be of interior quality in terms of lack of uniformity, presence of immature seeds and level of dockage, consequently the nutritional quality assessments obtained may have underrated the potential value of rapeseed meal of this type.

Seventy-two 23-kg growing pigs were allotted to 9 different barley-wheat based rations as indicated in Table V, such that standard rapeseed meal was compared with Bronowski rapeseed meal at levels of 3.8, 7.5, 11.3 and 15.0% of the ration. A soybean meal-fishmeal protein supplement was used as a control.

There were no differences ($P < .05$) in average daily gains between treatments nor in daily feed intakes. All the observed ration differences were smaller than the differences between the sexes (gilts and barrows). The efficiency of feed conversion was excellent by modern standards on all rations, averaging 2.85 kg feed DM/kg gain or 3.13 air-dry (10% moisture) feed/kg gain.

In digestibility studies of the same rations it was found that the rapeseed meal rations (both types) had protein and energy

fractions that were less digestible than the soybean-fishmeal control. This was to be expected because of the somewhat higher crude fibre content of the rapeseed meal. In view of the differences in digestibility (about 4 percentage units for all rapeseed meals versus all soybean-fishmeal supplement) the efficiency of energy utilization was examined (Table V). The two rapeseed meals required 10 mcal DE/kg gain compared to 9.77 for the control.

At the conclusion of the feeding trial (89 kg) the pigs were slaughtered and scored according to the R.O.P. standards. No treatment differences were found in fat or lean distribution or in predicted yield of trimmed cuts.

TABLE V

GROWTH RATES, FEED AND DIGESTIBLE ENERGY UTILIZATION BY 23-89 kg PIGS

Ration	Daily Gain	Daily Feed	Feed/Gain Ratio[a]	DE/kg Gain
	kg	kg		mcal
Soybean fishmeal control	0.68	1.87	2.73	9.77
3.8% Bronowski Meal	0.68	1.92	2.81	10.03
7.5 " "	0.67	1.86	2.77	9.72
11.3 " "	0.65	1.86	2.87	10.12
15.0 " "	0.65	1.89	2.93	10.01
3.8% B. campestris Meal	0.68	1.87	2.74	9.75
7.5 " "	0.65	1.95	3.01	10.49
11.3 " "	0.65	1.83	2.83	9.48
15.0 " "	0.63	1.83	3.04	10.30

[a] - Feed intake on a dry matter basis.

These results confirm previous findings to the effect that up to 15% of regular rapeseed meal can be used successfully for growing-finishing pigs. They also indicate that Bronowski rapeseed meal is at least equal to ordinary rapeseed meal for this purpose. It would be of interest to test meal derived from higher quality Bronowski or other glucosinolate-free seed which presumably would contain less fibre.

BREEDING FEMALES

Reproduction studies involving gilts fed Bronowski rapeseed meal throughout pregnancy were also conducted. The ration contained 10% Bronowski meal and 1% fishmeal (herring) as the entire protein supplement to a barley-oats-alfalfa meal ration. Vitamins and minerals were added to provide for requirements. The results of the trial are shown in Table 6 along with data from gilts fed regular rapeseed meal and gilts and sows fed rations containing no rapeseed meal.

It is observed that gilts fed the regular rapeseed meal had gestation periods 2-3 days longer than normal, they farrowed fewer pigs, had more stillborn pigs and weaned fewer pigs than did the control gilts. On the other hand the gilts fed Bronowski rapeseed meal rations, farrowed an average of 9.7 pigs compared to 10.0 for the controls and 98% of the pigs born were alive at birth. Two of the Bronowski gilts failed to settle down after farrowing and their litters performed poorly but the other 7 gilts responded well in all stages of reproduction and lactation. In the case of the gilts fed the regular rapeseed meal, the herdsman reported abnormal restlessness in all the gilts before and after farrowing.

On the basis of these limited observations it appears probable that glucosinolate-free or glucosinolate-low rapeseed meal can be used without difficulties in the rations of pregnant and lactating gilts.

POTENTIAL MONETARY ADVANTAGES IN DEVELOPING IMPROVED RAPESEED MEALS

The technique known as parametric linear programming has been applied to the assessment of the potential economic worth of rapeseed meals having above-normal digestible energy and protein contents. Rapeseed meal has often been criticized by feed manufacturers as being high in crude fibre content, low in digestible or metabolizable energy and low in protein content in relation to alternative feedstuffs. The implied consequence of this is that rapeseed meal would be more extensively used if improved in these characteristics.

Parametric linear programming in effect offers the computer, in this case, rapeseed meal (RSM) at gradually decreasing costs in order to find out at what maximum cost RSM would first enter a least-cost ration formula and at what level. The operations then proceed to determine all the additional formulas that would be possible at successive cost reductions, ultimately

TABLE VI

REPRODUCTION PERFORMANCE OF GILTS FED RAPESEED MEAL RATIONS

	Control Gilts	Rapeseed Meal Gilts	Bronowski Rapeseed Meal Gilts	Control Sows
Number of gilts or sows	18	13	9	30
Gestation period, days	114.6	117.2	114.6	114.7
Pigs farrowed/litter	10	8.4	9.7	12.2
Pigs farrowed alive	8.7	7.2	9.7	10.4
Birth weight, kg	1.18	1.18	1.27	1.50
10-day weight, kg	2.82	3.04	2.94	3.32
Pigs weaned	8.2	6.0	6.6[A]	8.8
Weaning age, days	30.7	32.7	28	23.0
Weaning weight, kg	7.2	7.4	7.4	8.1

A - Two gilts (full sisters) failed to nurse pigs satisfactorily. Excluding these two gilts the average number weaned was 8.0.

determining maximum use level and the related cost. In our studies, as yet preliminary, we used several Canadian market situations, obtaining lists of ingredients locally available and their costs, and then had pig grower rations formulated to meet known nutritional requirements.

The kinds of RSM tested were (a) one containing 2,900 kcal DE/kg and 40.5% crude protein, (b) one containing 3,300 kcal DE/kg, otherwise similar to above, (c) one containing 2,900 kcal DE/kg and 45.8% crude protein and (d) one containing 3,300 kcal DE/kg and 45.8% crude protein. (It was intended that the 3,300 kcal RSM would be regarded as a high energy meal, but it has recently been found to be about average quality, therefore further studies are needed using possibly 3,500-3,600 kcal DE to represent a low-fibre, high energy RSM).

In some of our studies both minimum and maximum protein specifications were given for the rations and in others in only a minimum was called for. In many instances it was found that removing the computer restriction on the protein level permitted lower cost rations to be formulated and also allowed more rapeseed meal to be used.

With regard to potential value of improvements in protein and/or energy levels in RSM it was found, in 20 ration printouts with restricted protein levels, that increasing the DE value was worthwhile in only 5% of the formulations but increasing either protein or protein and DE resulted in higher values in 15% of the cases.

When protein level in the diet was unrestricted and 51 ration printouts were obtained, there was a clear advantage for high-energy high-protein RSM with 48 of the rations showing this RSM to be worth more than "standard" RSM. The high protein RSM and the high DE RSM were superior to "standard" RSM in 30-35% of the formulas.

Obviously it is premature to indicate specific monetary advantages likely to be associated with particular increments of protein or DE in RSM. More types of ration formulas and more market situations need to be tested. Levels of protein in excess of 45.8% and levels of DE in excess of 3,300 kcal/kg need to be assessed, since such meals are theoretically possible through genetic and/or processing technology. However this technique appears to be a useful one in relation to decision-making on the merits of striving for potential improvements in the nutritional quality of a feedstuff. Tentatively it can be assumed that striving for higher energy values in RSM will only be of appreciable economic value if simultaneously associated with increased protein content.