

RAPESEED MEAL IN RUMINANT RATIONS
DAIRY CATTLE

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Several experiments have been conducted in Canada during the past few years to study the use of rapeseed meal in starter, grower and lactation rations. Some of these data are published, part have been presented at meetings and some are not yet published or completely analyzed. This paper attempts to bring together the recent Canadian data relative to rapeseed meal in dairy rations.

RAPESEED MEAL IN CALF AND GROWING RATIONS

Studies were undertaken at the University of Guelph to determine the energy and protein value of rapeseed meal (RSM) compared to that of soybean meal (SBM) in calf starters at two levels of energy intake. Digestible energy and protein values were determined by the difference method at maintenance energy intake and ad lib intake. Rapeseed meal or SBM (Table I) was mixed with the basal ration in equal quantities for the maintenance level. For the growth level of intake, the basal ration supplied 1 x maintenance and rapeseed or soy supplied up to 1 x maintenance. The basal ration contained cracked corn 30%, rolled oats 27.4%, soybean meal 26.1%, bran 10%, molasses 5.0%, dicalcium phosphate 1.0% and salt 0.5%. Twenty male Holstein calves (90-120 kg) were used in the experiment with four calves per treatment. Ad lib intake of the basal plus RSM or SBM resulted in growth rates of 0.55 and 0.75 kg per day over a short period of time. Digestible energy intake was 1.66 and 1.92 x maintenance for the rape-basal and soy-basal diets, respectively. Crude protein digestion coefficients were similar for RSM and SBM (Table II) resulting in digestible protein contents of 35 and 47% respectively. Level of intake had no significant effect on crude protein digestion coefficients. However, gross energy digestion coefficients for RSM and SBM increased 8 to 10 percentage points at the higher level of intake.

TABLE I
COMPOSITION OF RAPESEED MEAL, SOYBEAN MEAL
AND THE BASAL DIET[★]

Feed	% Dry matter	Percent of dry matter					Gross energy Kcal/g
		Crude protein	Crude fiber	Ether extract	Ash	NFE	
Rapeseed meal	87.6	39.4	17.5	3.1	7.3	32.7	4.43
Soybean meal	89.2	50.9	8.2	1.0	6.4	33.5	4.28
Basal diet	88.6	21.6	8.3	3.8	5.1	61.2	4.66

★ University of Guelph

The mean caloric values of RSM and SBM derived by the difference method were 3213 and 2926 Kcal DE per kg dry matter respectively. In terms of digestible energy used per kg body weight gain above maintenance requirements, the efficiency of RSM was 5360 Kcal per kg gain and SBM 5780 Kcal. Thus from these studies it appears that RSM is lower in digestible protein content but equal to or greater in DE value when compared with SBM.

A second experiment was conducted at the University of Guelph to examine the growth rate of calves receiving starters containing four levels of RSM. Thirty-two heifer calves were randomly allotted to one of four starter treatments. Four breeds were used, however, Ayrshire, Guernsey and Jersey calves were considered as one breed and 4 calves from this group and 4 Holstein calves were allotted to each treatment. Whole milk was fed by weight as a percentage of birth weight over the first 5-6 weeks of life such that each calf consumed a total of 113.6 kg of whole milk. A grass legume hay mixture was allowed on a free choice basis starting at 10 days of age. Four pelleted calf starters were formulated with 0, 8, 16 and 24% of the grain mixture as rapeseed meal (Table III). Rapeseed meal as a percent of the total ration was 0, 6.2, 12 and 17.6%. Statistical analysis has not been completed on the data. However, the data would suggest that up to 16% RSM had no effect on animal performance (Table IV). The 24% level of RSM had little effect on weight gain but appeared to result in higher hay intake and lower daily starter intake.

It is of interest to note that the daily hay intake appeared to increase at a more rapid rate than the decrease found in starter consumption as the level of RSM increased.

TABLE II

DIGESTION COEFFICIENTS AND PERFORMANCE OF CALVES WHEN FED BASAL, RAPE-BASAL AND SOY-BASAL DIETS AT TWO LEVELS OF INTAKE

Item	Treatment				
	Basal	Rapeseed		Soybean	
	Maint.	Maint.	Growth	Maint.	Growth
No. of Calves	4	4	4	4	4
Crude Prot. Dig (%)	81.5	83.3	86.6	90.9	88.9
Gross Energy Dig. (%)	74.2 ^b	77.4 ^b	81.7 ^a	76.9 ^b	83.2 ^a
% of N Retained	32.3 ^b	14.7 ^a	33.0 ^b	35.3 ^b	26.9 ^b
Daily DM Intake (% body wt.)	1.61	1.49	2.06	1.53	2.28
Daily Gain	.04	.02	.55	.06	.75
DE Intake/kg Gain (Mecgal.)	-	-	13.42	-	12.07
DE/kg Body Wt. Gain above Maint. (Mecgal.)	-	-	5.36	-	5.78
Digestion Coefficients by Difference					
Crude Protein (%)	-	85.6	91.8	93.8	92.6
Gross Energy (%)	-	81.0 ^a	89.3 ^b	77.7 ^a	87.7 ^b
DM (%)	-	74.4	89.1	78.7	88.6

Means followed by different letters are significantly different (P<0.01).

A study was carried out at the University of Manitoba (Financial support was furnished by United Grain Growers Limited and rapeseed meal by Co-op Vegetable Oils Ltd., Altona.) to determine the effect of rapeseed meal on feed intake and growth of dairy calves when RSM replaced SBM and made up 0, 6.8 or 13.7% of the total ration. Thirty heifer calves (Holstein, Holstein-Brown Swiss and Holstein-Brown Swiss-Ayrshire cross breeds) were divided into three groups and assigned to one of three complete rations at birth (Table V). Whole milk was fed at the rate of 4.5 kg for 35 days and 2.3 for an additional 10 days. The experiment

was divided into four periods (Period I. birth to 159-170 kg, II. 159-170 to 330-340 kg, III. 330-340 kg to parturition and IV. first 60 days of lactation). Heifers were artificially inseminated as soon as possible after they weighed 330-340 kg. The experimental rations containing 13.7, 6.8 and 0% RSM were pelleted and fed free choice during periods I and II. Similar non-pelleted rations were fed in limited amounts during period III, such that the heifers would gain about 0.77 kg per day. Long hay and a control grain mix were fed free choice in place of the experimental rations starting one week prepartum.

TABLE III
COMPOSITION OF STARTERS CONTAINING FOUR LEVELS
OF RAPESEED MEAL (UNIVERSITY OF GUELPH)

	0	8%	16% lbs.	24%
Cracked Corn	600	600	600	600
Rolled Oats	470	470	470	470
Wheat Bran	200	200	200	200
Soybean Meal	550	415	280	120
Rapeseed Meal	0	160	320	480
Molasses	150	125	100	100
Dicalcium Phosphate	20	20	20	20
Salt	10	10	10	10
Estimated Protein %	19.1	19.3	19.5	19.2
Estimated TDN %	71.9	71.6	71.3	70.8

1500 I.U. of Vitamin A and 300 I.U. of Vitamin D were added per pound of feed.

TABLE IV

EFFECT OF FOUR LEVELS OF RAPESEED MEAL
ON PERFORMANCE OF HEIFER CALVES*

Item	Treatment			
	0	8%	16%	24%
Starting wt. (kg)	34.9	33.0	37.3	36.6
Final wt. (kg)	113.6	114.2	114.0	113.8
Weight gain (kg)	78.7	81.2	76.7	77.2
Av. daily gain (kg)	.72	.66	.68	.64
Days from birth to 113.4 kg	110	123	113	120
Total milk (kg)	113.8	109.2	114.8	112.6
Total starter (kg)	189.5	211.7	192.2	198.9
Starter/day (kg) (exclude birth-10 days)	1.89	1.87	1.86	1.81
Total hay (kg)	50.6	60.6	62.7	71.3
Hay/day kg - exclude birth-10 days	.50	.53	.61	.65

*Statistical analysis not completed.

TABLE V

EXPERIMENTAL RATIONS FOR HEIFERS RECEIVING DIFFERENT LEVELS
OF RAPESEED MEAL FROM BIRTH TO FIRST CALF**

Ingredient	Treatment		
	Rapeseed	Mixture	Soybean
Barley	336	353	370
Rapeseed Meal	137	68	-
Soybean Meal	-	52	103
Molasses	12	12	12
Mineral Mix*	15	15	15
Hay (ground)	500	500	500
	1000	1000	1000

*Contained Rock Phos, Ca Carbonate, trace minerals and vitamin A

**University of Manitoba

TABLE VI
EFFECT OF THREE LEVELS OF RAPESEED MEAL
ON ANIMAL PERFORMANCE

Item	Treatment		
	Rapeseed	Mixture	Soybean
Total Milk (kg)	179	195	185
Total Feed Intake (kg)			
Period I	454	442	447
Period II	<u>1083</u>	<u>1176</u>	<u>1158</u>
Total	1537	1618	1605
Daily Feed Intake (kg)			
Period I	2.85	2.82	2.84
Period II	6.62	7.63	7.40
Feed per Gain			
Period I	3.61	3.46	3.47
Period II	6.35	6.91	6.81
Daily Gain (kg)			
Period I	.79	.82	.83
Period II	1.05	1.11	1.10
Days to Reach			
159-170 kg	159	156	157
Days to Reach			
330-340 kg	319	308	307
Wither Height (cm)	117.0	114.4	114.5
Heart Girth (cm)	155.	156.7	157.6

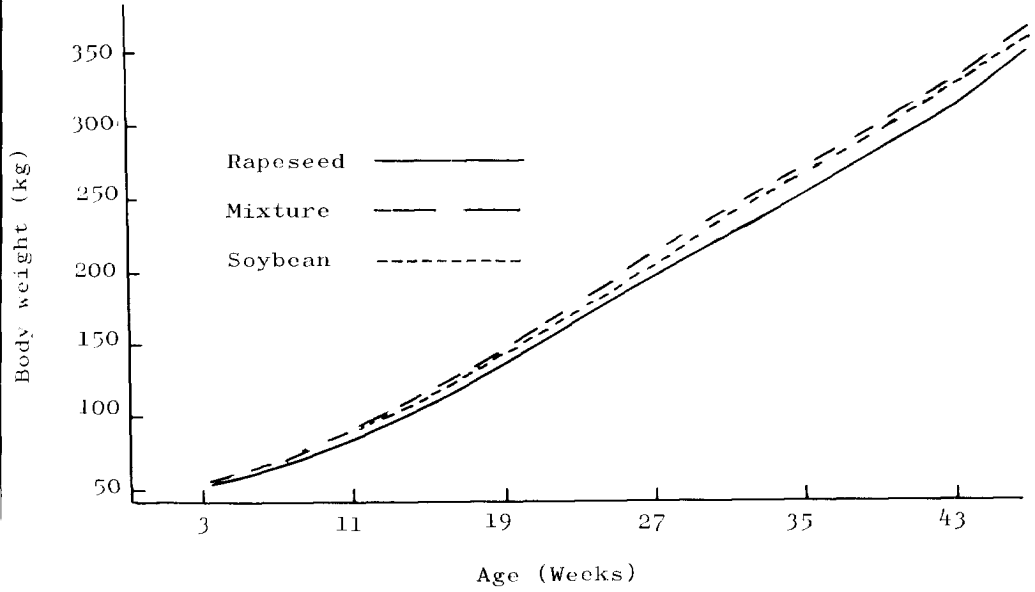


FIGURE I

GROWTH CURVES OF CALVES RECEIVING THREE LEVELS OF RAPESEED MEAL OVER AN EXTENDED PERIOD OF TIME (UNIVERSITY OF MANITOBA)

There were no significant differences ($P>0.05$) in feed intake, weight gain, feed efficiency, wither height or heart girth due to level of RSM in the ration (Table VI and Fig. 1). The level of rapeseed meal did not significantly ($P>0.05$) affect reproduction or milk production (Table VII); however, the number of animals is limited. The contemporary comparisons on the average are negative for the heifers on this experiment. This might be explained by the fact that these heifers calved at a young age (some at 19 months).

TABLE VII

EFFECT OF RAPESEED LEVELS DURING THE GROWING PERIOD
ON REPRODUCTION AND PRODUCTION LEVELS

Item	Treatment		
	Rapeseed	Mixture	Soybean
No. of Heifers	8	9	8
Age at First Service (days)	342	335	344
Services/Conception (1)	2.0	1.44	1.75
Age at Parturition (days)	654	633	679
No. of Heifers	8	7	7
Av. Milk First 60 Days (kg/day)	13.2	13.9	13.7
BCA			
Milk	90.0	102.3	101.0
Fat	89.7	109.8	105.6
Contemp. Comparison			
Milk	-15.4	-7.5	-5.7
Fat	-15.8	-1.8	-5.4

(1)Based on cows that calved.

Preliminary work is underway at the University of Manitoba with the objective of increasing the amount of RSM protein available to the lower G. I. tract of ruminants. A preliminary growth trial (weaned calves) and a N balance trial (bull calves from the growth trial) were carried out. The experimental diets contained: rapeseed meal 26% - either control or treated with formaldehyde, rolled barley 30%, corn starch 20%, barley straw 7.5%, ground hay 5%, corn oil 2%, cane molasses 8% and minerals and vitamin premix 1.45%. The results suggest that a part of the rapeseed protein was protected from breakdown by rumen

micro-organisms as rumen NH_3 levels were lower ($P < 0.05$) for calves receiving treated RSM (Table VIII). However, apparent protein digestibility of the treated RSM was also decreased. Urinary nitrogen was lower for calves receiving treated RSM thus counter-balancing the decreased digestibility resulting in a slightly higher nitrogen balance for the calves receiving treated RSM (7.4 g/day). However, this difference was not significant ($P > 0.05$).

TABLE VIII

THE NUTRITIVE VALUE OF FORMALDEHYDE TREATED RAPESEED MEAL IN THE RATION OF DAIRY CALVES[★]

Item	Treatments	
	Formal Treat.	Non Treat.
Growth Trial - 14 weeks		
No. of calves	4	5
Intake (kg)	391	356
Gain (kg)	85.4	85.3
Daily gain (kg)	0.87	0.87
Feed/gain	4.58	4.17
Rumen NH_3 (Nmg/100 ml)	2.5 ^b	5.6 ^a
Dig. Trial - 7 days		
No. observations	6	6
DM Intake (kg)	39.4	36.9
DM Dig. (%)	70.6 ^b	75.4 ^a
N in feces (% Intake)	40.4 ^a	25.6 ^b
CP Dig. (%)	59.3 ^b	74.4 ^a
N digested (g)	622	721
N in urine (% Intake)	24.7 ^b	42.1 ^a
N retained (g)	364	312
N retained (% Intake)	34.8	32.2

[★] University of Manitoba

ab Means followed by different lower case letters differ significantly ($P < 0.05$).

There appeared to be very little difference in rate of gain during the growth trial with a slight increase in consumption for animals receiving the treated RSM. It is of interest to note that these calves made good gains (0.86 kg/day) even though rapeseed meal made up 26% of the total diet or about 60% of the total protein intake.

Summary

These data suggest that RSM can replace SBM in calf starters. Recent experiments indicate that calf rations providing for 0.68 to 0.90 kg gain per day should contain 12-14% CP. The amount of RSM required in complete calf rations might be about 20% with corn and 10% with barley. These levels are within dietary levels used in experiments reviewed in this paper.

With young growing ruminants the previously suggested limit of 10% RSM in the ration can no longer be accepted. These data would suggest that good growth can be achieved with up to 60% of the calf starter protein in the form of commercial RSM.

RAPESEED MEAL IN LACTATION RATIONS

A study was recently completed at the CDA research station, Agassiz, B. C. to study the effects of high levels of rapeseed meal on milk production. Ten pairs of lactating Holstein-Friesen cows were fed 7.5% CP (DM basis) corn silage (27% DM) at the rate of 12.3 kg per 100 kg of body weight in a 112 day continuous feeding trial. A grain ration containing either SBM or RSM at 24% and 27% of the total grain mix, respectively, was fed at the rate of about 1 kg of grain to 3 kg of 4% fat corrected milk. The grain ration containing rapeseed meal was offered at a slightly higher rate to account for the lower calculated energy content of this mix compared to the SBM mix. No other source of supplemental protein was used in the grain ration. Cows were fed individually in a stanchion system for 1½ to 2 hr at 7 a.m., 11:45 a.m. and 5 p.m., then released to a common yard and free stall sleeping quarters. Four cows from each treatment were placed on a nitrogen balance and digestion trial at the end of the 112 day feeding period.

Results of this study suggest (statistical analysis not done) that total milk production and fat test and thus fat corrected milk yield were depressed (Table IX) with the high level of RSM. Total decline (%) in 4% fat corrected milk yield was almost doubled when the high level of rapeseed meal replaced soybean

TABLE IX

DAILY PERFORMANCE, EFFICIENCY OF NITROGEN UTILIZATION AND DIGESTIBILITY FOR LACTATING COWS FED RAPESEED OR SOYBEAN MEAL AS THE ONLY SOURCE OF SUPPLEMENTAL PROTEIN WITH CORN SILAGE AS THE ROUGHAGE SOURCE*

Item	Treatment	
	Soybean Meal	Rapeseed Meal
No. of cows	10	10
Days on experiment	112	112
Feed Intake (DM/day)		
Silage - kg	8.6	8.5
Grain - kg	7.0	6.5
Digestible protein intake - kg	1.48	1.21
Digestible protein requirement - kg	1.39	1.24
Production		
Milk - kg	23.0	21.8
Fat corrected milk (4%) - kg	21.4	18.6
Butterfat %	3.56	3.09
Protein %	3.46	3.35
Lactose %	4.84	4.84
Non-fat solids - kg	2.08	1.94
Total decline in 4% FCM-%	12.6	22.8
Body wt. change - kg	36.0	22.2
Digestibility of ration		
Crude protein - %	71.5	66.2
Dry matter - %	68.2	65.3
Nitrogen utilization (% of N consumed)		
Urine	29.7	25.7
Feces	28.5	33.3
Milk	34.3	33.7
Retained	7.4	7.0
Efficiency of N utilization - %	41.7	42.3

*CDA Research Station, Agassiz.

meal. This experiment was carried out during the summer and the observation was made that during nearly all the warmer periods (two or three days of above average temperatures) the incidence of cows going off feed was far greater for those receiving the RSM compared to those fed SBM. This might suggest that the cows receiving high levels of RSM had less ability to withstand heat stress.

Total ration CP digestibility was lower for the rapeseed ration; however, because of decreased urinary nitrogen there was little difference in overall efficiency of nitrogen utilization for the RSM and SBM rations. Total digestible protein intake was somewhat lower for the RSM compared to the SBM ration because of slightly lower grain intake and lower CP digestibility.

Three studies were carried out with dairy cows at the University of Manitoba to determine the effects of rapeseed meal (Table X) upon ad libitum grain consumption and resulting milk production (Ingalls et al Can. J. Animal Sci. 48:437, 1968).

The three trials indicate that (Tables XI, XII, XIII) when roughage is limited and grain fed ad libitum, grain consumption will be significantly reduced when RSM (12-13%) replaces SBM (10%) in the grain ration. However, these levels of RSM had no significant effect on milk and FCM yield or milk composition. These results are in contrast to the results reviewed in the first experiment when a higher level of RSM was fed. In the former trial cows consumed 1.8 kg of rapeseed meal whereas in the later trial consumption varied from 1.3 - 1.6 kg per day.

Summary

Results of the experiments with lactating cows indicate that RSM used at high levels in the grain ration (27%) in place of SBM resulted in a somewhat lower milk yield and fat test. When RSM (largely Tanka) made up 12-13% of the grain ration there was a significant decrease in ad libitum grain consumption with no effect on milk yield or milk composition at the levels of production obtained in three experiments. Replacing SBM with RSM as 9% of the grain mixture had no significant effect on consumption. These data would suggest that where maximum grain intake is required RSM should not make up more than 10% of the grain mixture for lactating cows. In practice, where legume grass hay and barley, oats and wheat make up the ration, 10% additional protein supplement in the form of RSM will generally meet protein requirements for lactating cows.

TABLE X

COMPOSITION OF EXPERIMENTAL RATIONS**

Ration	Exp. 1			Exp. 2			Exp. 3			
	Soy	Rape	Urea	6%	9%	12%	Soy	Urea + rape	Rape	Urea
	Ingredient (%)									
Corn	86.7	82.7	94.3	41.7	41.3	40.9	-	-	-	-
Barley	-	-	-	21.0	21.0	21.0	64.8	68.0	62.8	73.2
Oats	-	-	-	25.0	25.0	25.0	20.0	20.0	20.0	20.0
Soybean meal	9.0	-	-	5.2	2.6	-	10.0	-	-	-
Rapeseed meal	-	13.0	-	6.0	9.0	12.0	-	6.0	12.0	-
Urea	-	-	1.4	-	-	-	-	0.8	-	1.6
Rock phosphate	1.3	1.3	1.3	0.9	0.9	0.9	1.0	1.0	1.0	1.0
Salt (cobalt-iodized)	1.0	1.0	1.0	0.2	0.2	0.2*	0.2*	0.2	0.2	0.2
Molasses	2.0	2.0	2.0	-	-	-	4.0	4.0	4.0	4.0
Protein content of total ration -										
DM basis (%)	12.3	12.6	12.7	12.9	13.1	12.9	13.4	13.4	12.9	14.0

* Water supply contained salt

** University of Manitoba

TABLE XI

EFFECTS OF RATIONS CONTAINING SOYBEAN MEAL, RAPESEED MEAL AND UREA ON FEED CONSUMPTION AND PERFORMANCE OF DAIRY COWS (EXPERIMENT 1)

Item	Ration		
	Soybean	Rapeseed	Urea
Av. daily intake (DM)			
Hay (kg)	3.4	3.6	3.4
Grain (kg)	16.3Aa	12.0B	14.6Ab
Protein supplement (kg)	1.47	1.56	0.20
Av. daily FCM prod. (kg)	16.9	15.7	16.1
Av. butterfat test (%)	3.68	3.64	3.63
Av. weight grain (kg/day)	0.54	0.07	0.60
Av. weight (kg)	572	568	565

ab Means followed by different lower case letters, differ significantly ($P < 0.05$)

AB Means followed by different capital letters differ significantly ($P < 0.01$)

TABLE XII

EFFECTS OF RATIONS CONTAINING 6, 9 AND 12% RAPESEED MEAL
ON FEED CONSUMPTION AND PERFORMANCE OF DAIRY COWS
(EXPERIMENT 2)

Item	% Rapeseed meal		
	6%	9%	12%
Av. daily feed intake (DM)			
Hay (g/kg) ^X	4.7	5.0	5.2
Silage (g/kg)	10.3	10.7	10.6
Grain (g/kg)	23.0A	22.7ABa	21.4Bb
Rapeseed meal (kg)	0.79	1.11	1.33
Av. daily milk prod. (kg)	19.8	20.1	19.7
Av. BF test (%)	3.36	3.39	3.36
Av. SNF test (%)	8.75	8.69	8.64
Av. daily wt. gain (kg)	0.30	0.22	0.19
Av. weight (kg)	58 ¹ / ₄	552	521
Av. PBI (g/100 ml)	7.1	7.3	7.6

^X Intake is expressed as g/kg to compensate for av. weight differences among treatments

ab Means followed by different lower case letters differ significantly (P<0.05)

AB Means followed by different capital letters differ significantly (P<0.01)

TABLE XIII

EFFECTS OF RATIONS CONTAINING UREA, AND/OR RAPESEED MEAL
ON FEED CONSUMPTION AND PERFORMANCE OF DAIRY COWS
(EXPERIMENT 3)

	Soy	Rape + Urea	Rape	Urea
Av. daily feed intake (DM)				
Hay (kg)	3.0	2.9	2.9	2.9
Silage (kg)	2.9	2.7	2.9	2.7
Grain (kg)	12.7A	11.2B	11.5B	9.8C
Protein suppl. (kg)	1.27	-	1.38	0.16
Av. daily milk prod. (kg)	20.3Aa	19.7Ab	20.4Aa	17.8B
Av. daily FCM (kg)	17.5ABa	17.9ABa	18.9Aa	16.3Bb
Av. BF test (%)	3.3	3.4	3.5	3.4
Av. SNF test (%)	8.47	8.46	8.44	8.40
Av. milk protein (%)	3.43	3.55	3.43	3.51

ab Means followed by different lower case letters differ significantly (P<0.05)

ABC Means followed by different capital letters differ significantly (P<0.01)