Canola Meal Research Meeting

Understanding the Nutritional Value of Canola Meal and How It Can Be Enhanced for Dairy Cattle Feeding

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Outline of Presentation

- Nutritional characteristics of canola meal
- Dairy production trials with canola meal as major protein source
  - Canola meal
  - Rumen-protected canola
- Mechanisms for observed responses?
- Getting the best out of canola meal
  - Manipulating N metabolism

Chemical Composition of Canola Meal

	Canola Seed[1]	Canola Meal[1]	Soybean Meal
	Dry Matter Basis, %		
Crude Protein	22.2	38.9	49.9
Oil	43.0	3.9	1.5
Crude Fiber	8.0	13.3	7.0
Acid Detergent Fiber	10.9	19.1	10.0
Neutral Detergent Fiber	13.5	23.6	15.0
Calcium	0.40	0.70	0.34
Phosphorus	0.68	1.20	0.70
NE_L (mcal/kg)	3.52	1.76	1.94

[1] *Hickling, D. 2001. Canola Meal Feed Industry Guide*

Summary of Canola Meal Dairy Trials

	Milk Yield, kg/d	
	Control[1]	Canola Meal
18 Production Trials	25.1	26.1
Highest Production Trial	39.8	41.4
Lowest Production Trial	17.2	16.9

- [1]Soybean meal or cottonseed meal
- Production responses: 0.1 to 4.3 kg/d

Hickling, D. 2001. Canola Meal Feed Industry Guide

Canola Meal as a Protein Ingredient

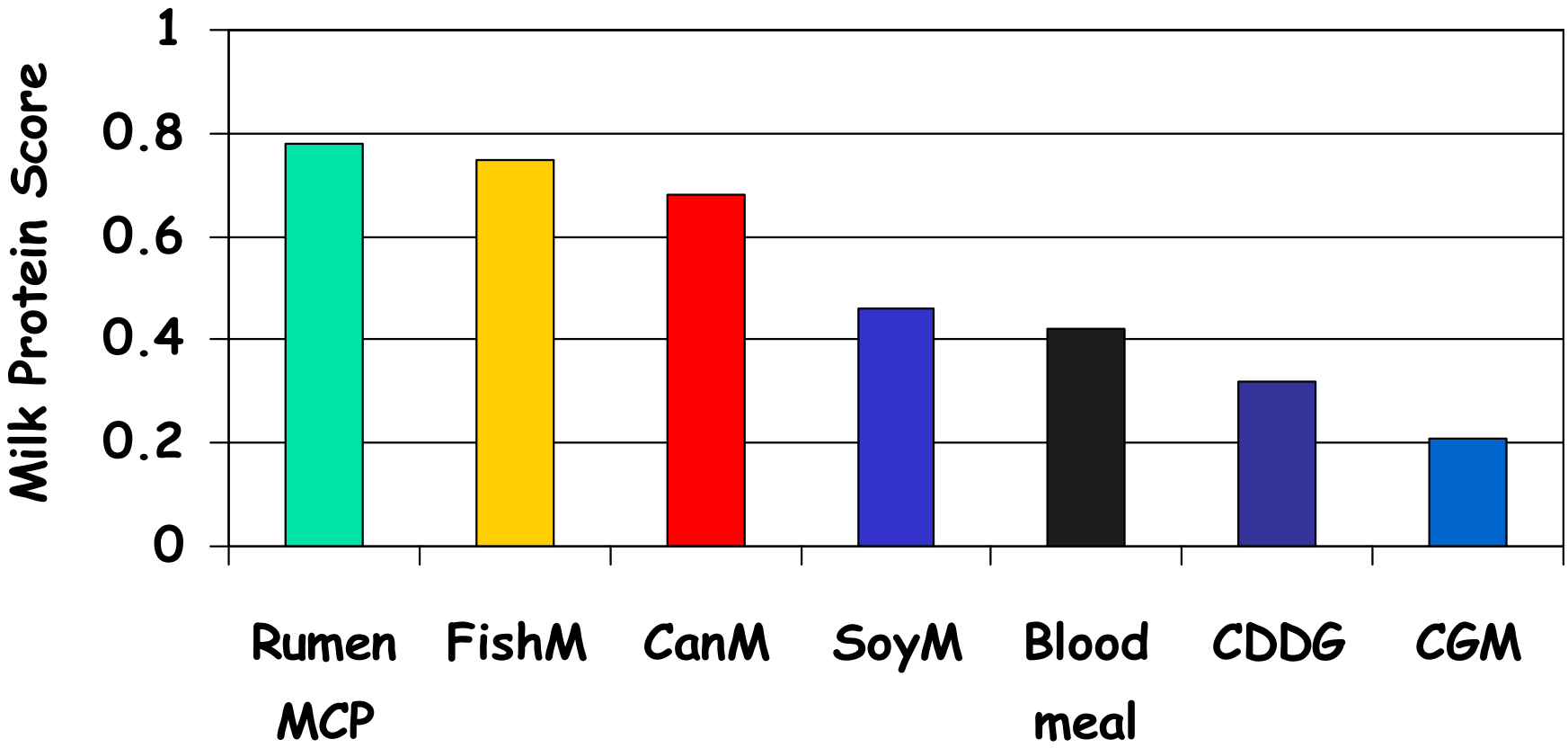
Why is canola meal such an excellent protein source for dairy cows?

Ingredient and MCP AA Composition Relative to Milk Protein

	Milk, %EAA	Amino Acid as % of Milk Protein		
		MCP	Canola meal	Soybean meal
Arginine	7.2	139	197	225
Histidine	5.5	**73**	**138**	111
Isoleucine	11.4	107	83	89
Leucine	19.5	81	**82**	88
Lysine	16.0	119	**84**	87
Methionine	5.5	84	**95**	**58**
Phenylalanine	10.0	104	103	116
Threonine	8.9	121	113	98
Tryptophan	3.0	90	115	93
Valine	12.0	85	88	78

NRC, 2001; Hickling, D. 2001. Canola Meal Feed Industry Guide

Relative Amino Acid Quality of Protein Ingredients



Schingoethe, D.J. Feedstuffs, March 18: 11

Metabolic Trials with Canola Meal

- A. F. Brito and G. A. Broderick. 2007. Effects of different protein supplements on milk production and nutrient utilization in lactating dairy cows. *Journal of Dairy Science 90:1816-1827*

- A. F. Brito, G. A. Broderick, and S. M. Reynal. 2007. Effects of different protein supplements on omasal nutrient flow and microbial protein synthesis in lactating dairy cows. *Journal of Dairy Science 90:1828-1841*

Metabolic Trials with Canola Meal

- 3 protein ingredients
  - Canola meal
  - Soybean meal
  - Cottonseed meal
- 12-16% on DM basis
  - Isonitrogenous, isocaloric
- Rumen-cannulated cows
  - Rumen measurements
  - Omasal nutrient flow
    - Omasal sampling technique

Protein Supplements and Cow Performance

	Protein Supplement		
	Canola meal	Cottonseed Meal	Soybean Meal
DMI, kg/d	26.0	25.2	24.7
Milk yield, kg/d	41.1	40.5	40.0
Fat, %	3.14	2.94	3.09
Fat, kg/d	1.29^{a}	1.18^{b}	1.22^{ab}
Protein, %	3.12^{a}	2.97^{b}	3.15^{a}
Protein, kg/d	1.27^{a}	1.18^{b}	1.23^{ab}

Brito and Broderick. 2007. J. Dairy Sci. 90:1816

Protein Supplements and Omasal EAA Flow

	Canola meal	Cottonseed Meal	Soybean Meal
Omasal flow, g/d			
Lysine	201	196	194
Methionine	73.9	70.3	67.9
Histidine	67.5[ab]	68.4[a]	62.1[b]
Total EAA	1496	1474	1418

Brito, Broderick and Reynal. 2007. J. Dairy Sci. 90:1828

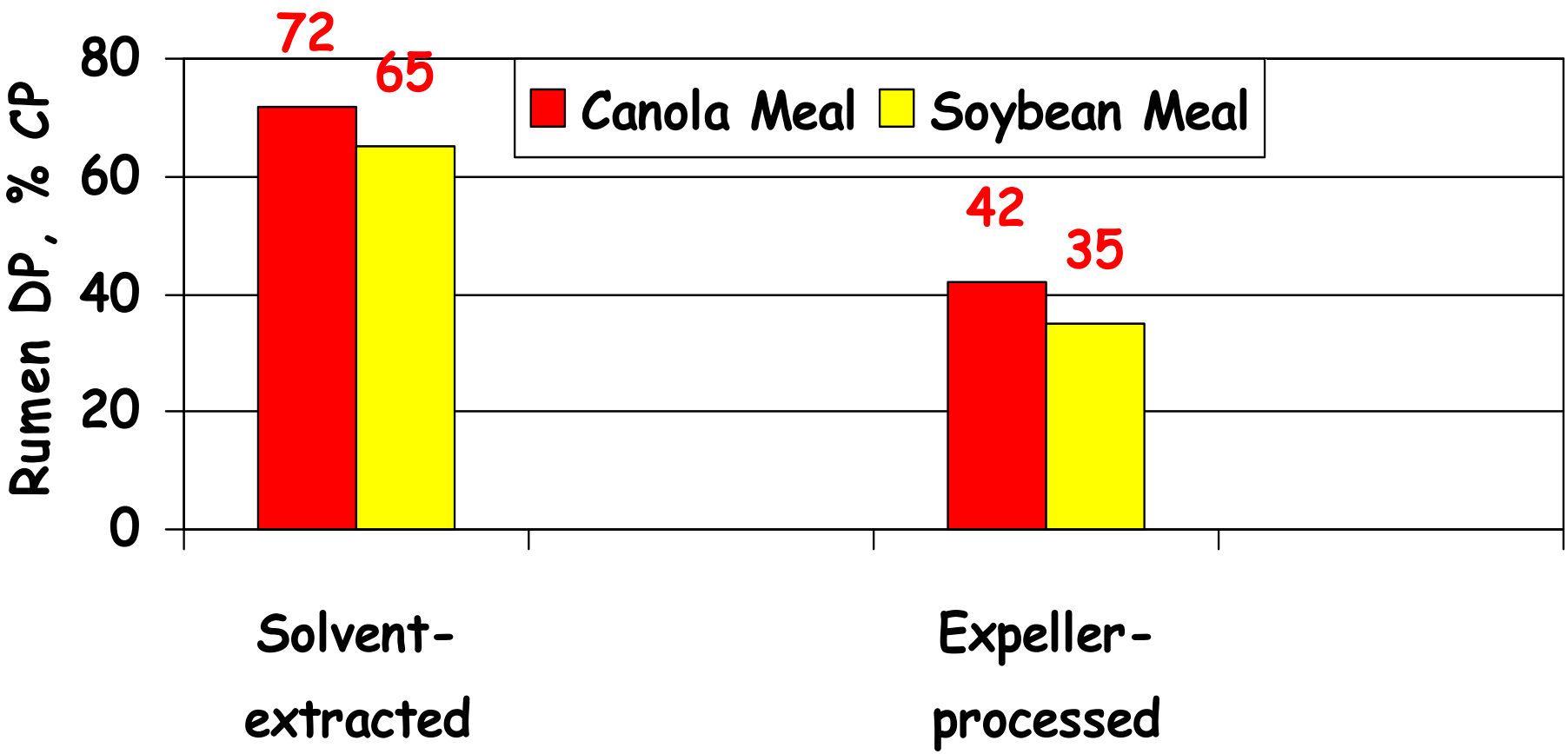
Protein Supplements and N Metabolism

	Canola meal	Cottonseed Meal	Soybean Meal
N intake, g/d	695	671	653
Omasal flow, g/d			
Total N	628	649	598
RUP	1150^{ab}	1348^{a}	1061^{b}
Microbial N	219	300	271
Ammonia-N	12.1^{a}	9.40^{b}	10.4^{b}

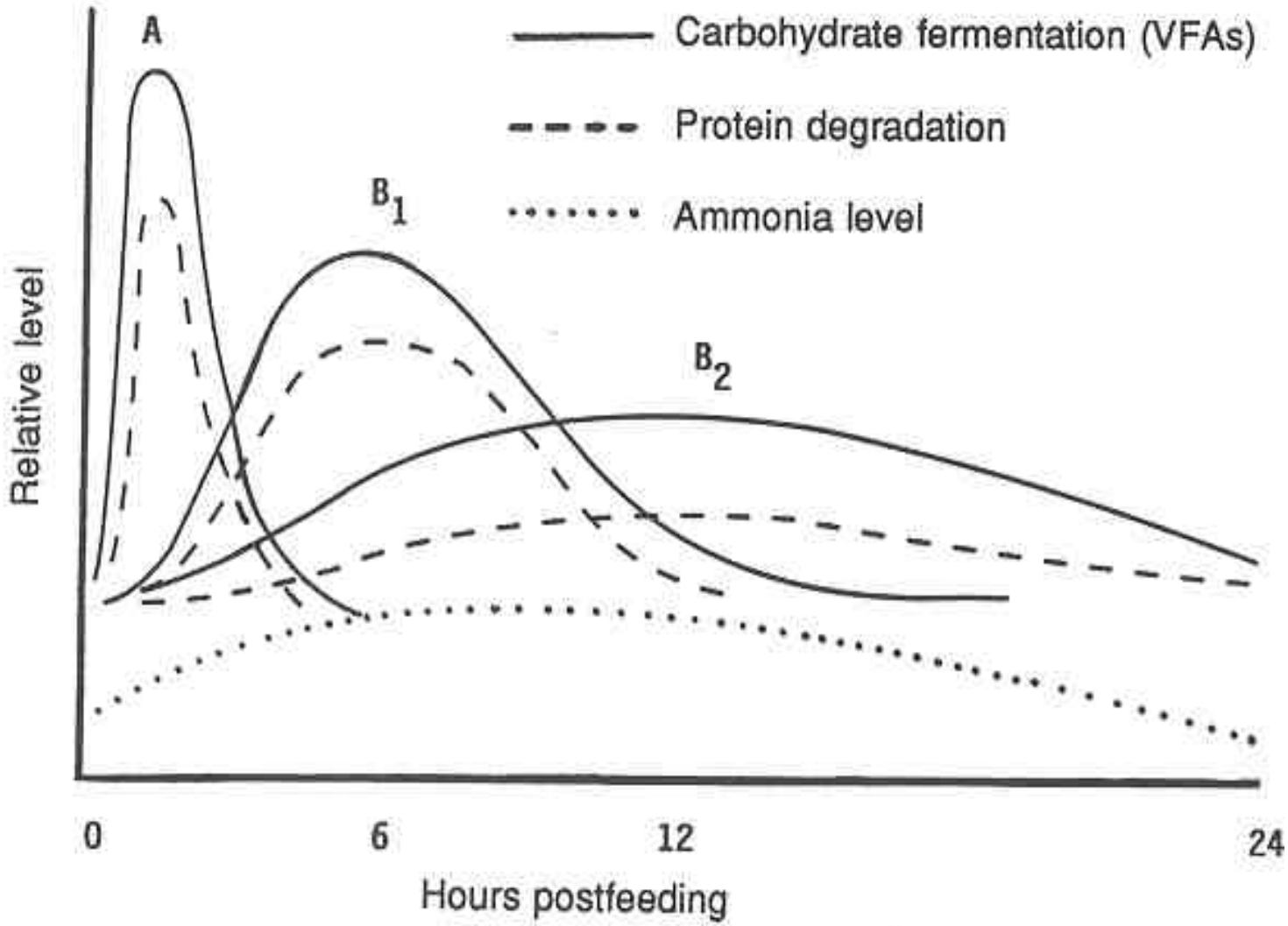
- Is energy availability limiting MCP production such that N is wasted?
  - Uncoupled fermentation?

Brito, Broderick and Reynal. 2007. J. Dairy Sci. 90:1828

Rumen Degradability of Protein Ingredients

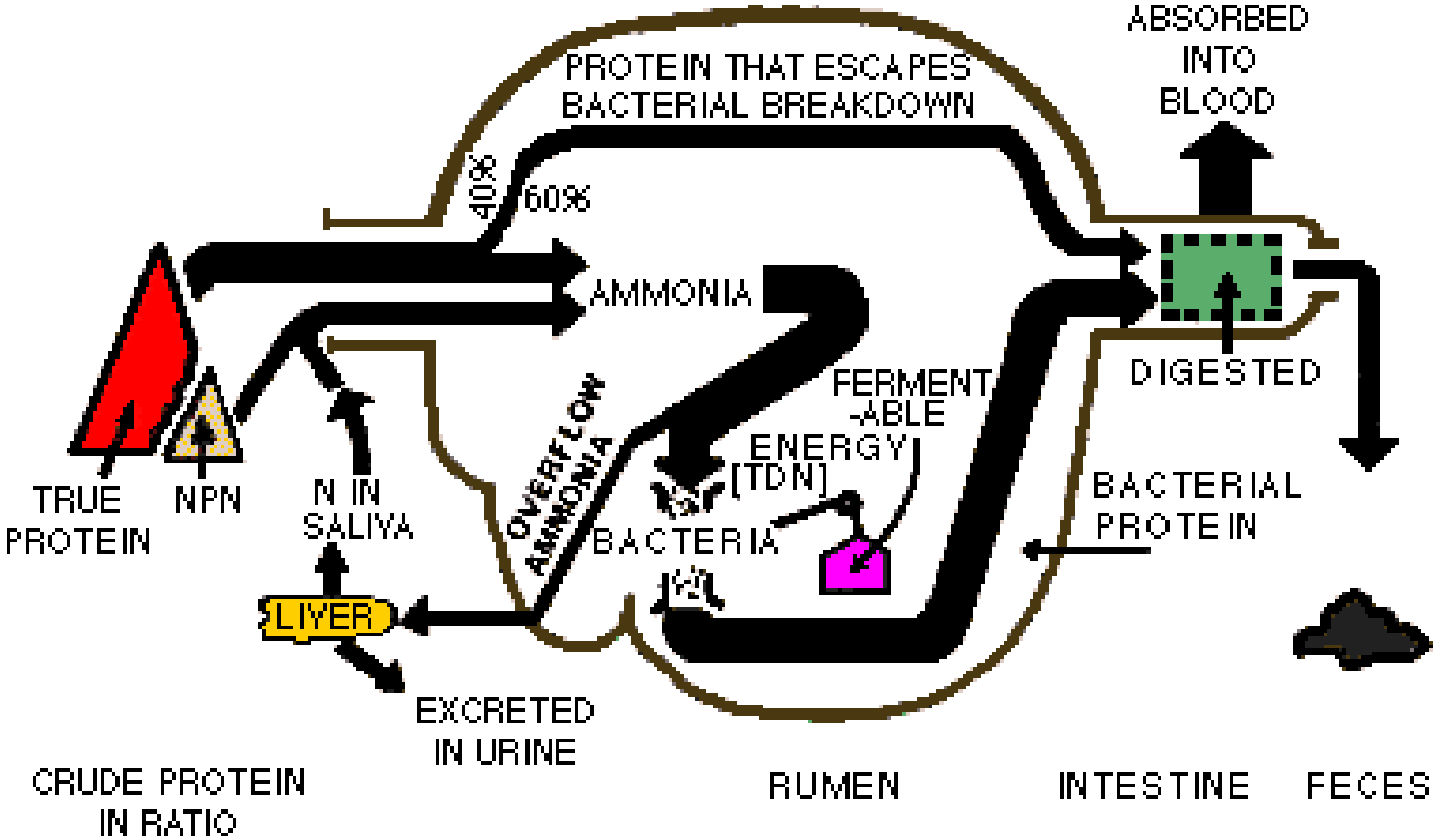


Carbohydrate and Protein Utilization Rates in the Rumen



Van Soest, P. J. 1996.

Overview of Nitrogen Metabolism in Ruminants



Source: www.agr.gc.gc/lethbridge

Enhancing Utilization of Canola Meal

How do we enhance efficiency of N utilization in diets containing canola meal as the major protein ingredient?

- 2 approaches
  - Recapture N as microbial crude protein

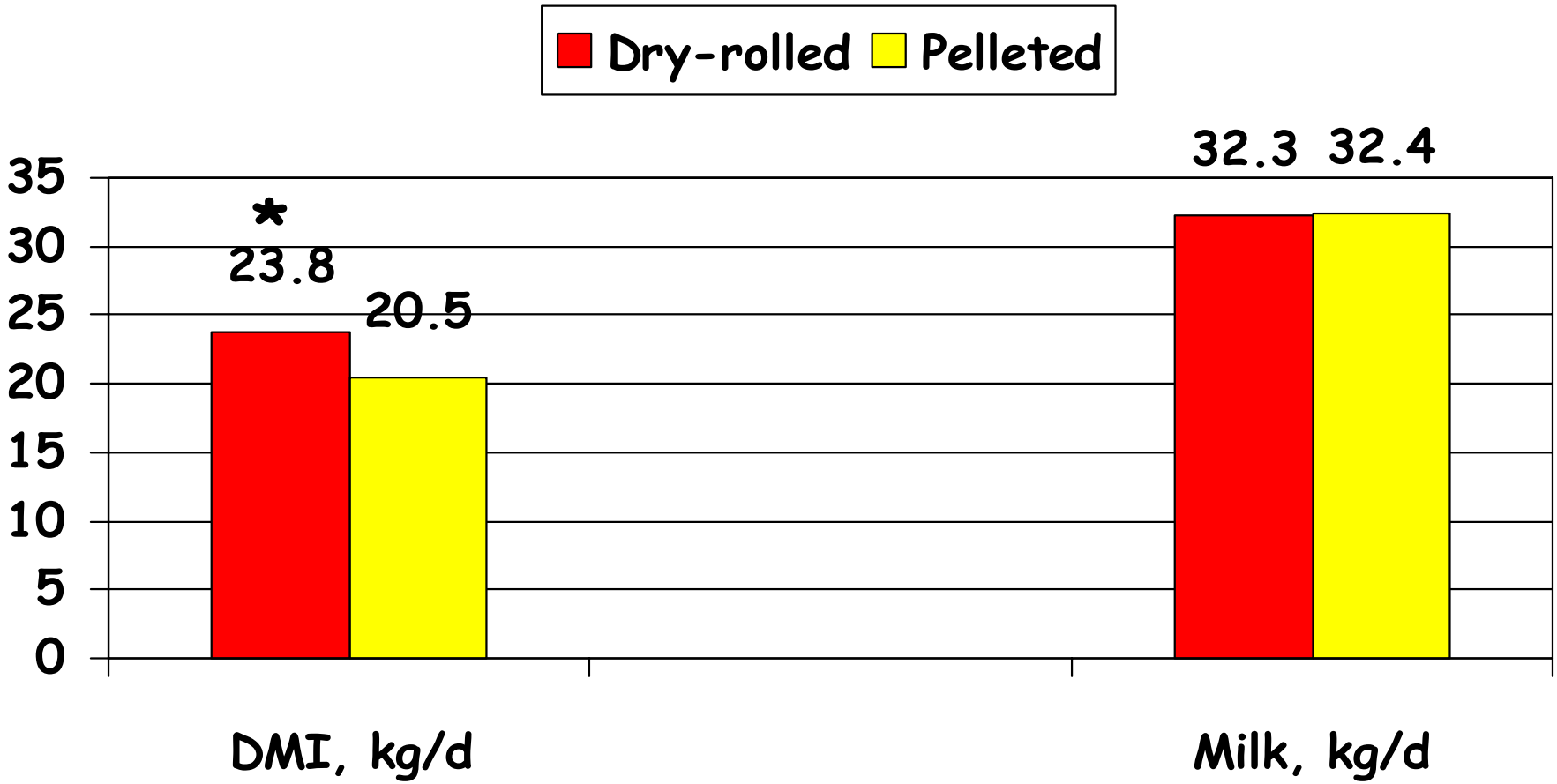
Metabolic Trials to Enhance N Utilization

- G. Gozho, M. Hobin, and T. Mutsvangwa. 2007. Effects of barley grain processing on N metabolism and N recycling in lactating dairy cows. *Journal of Dairy Science (accepted)*

Metabolic Trials with Canola Meal

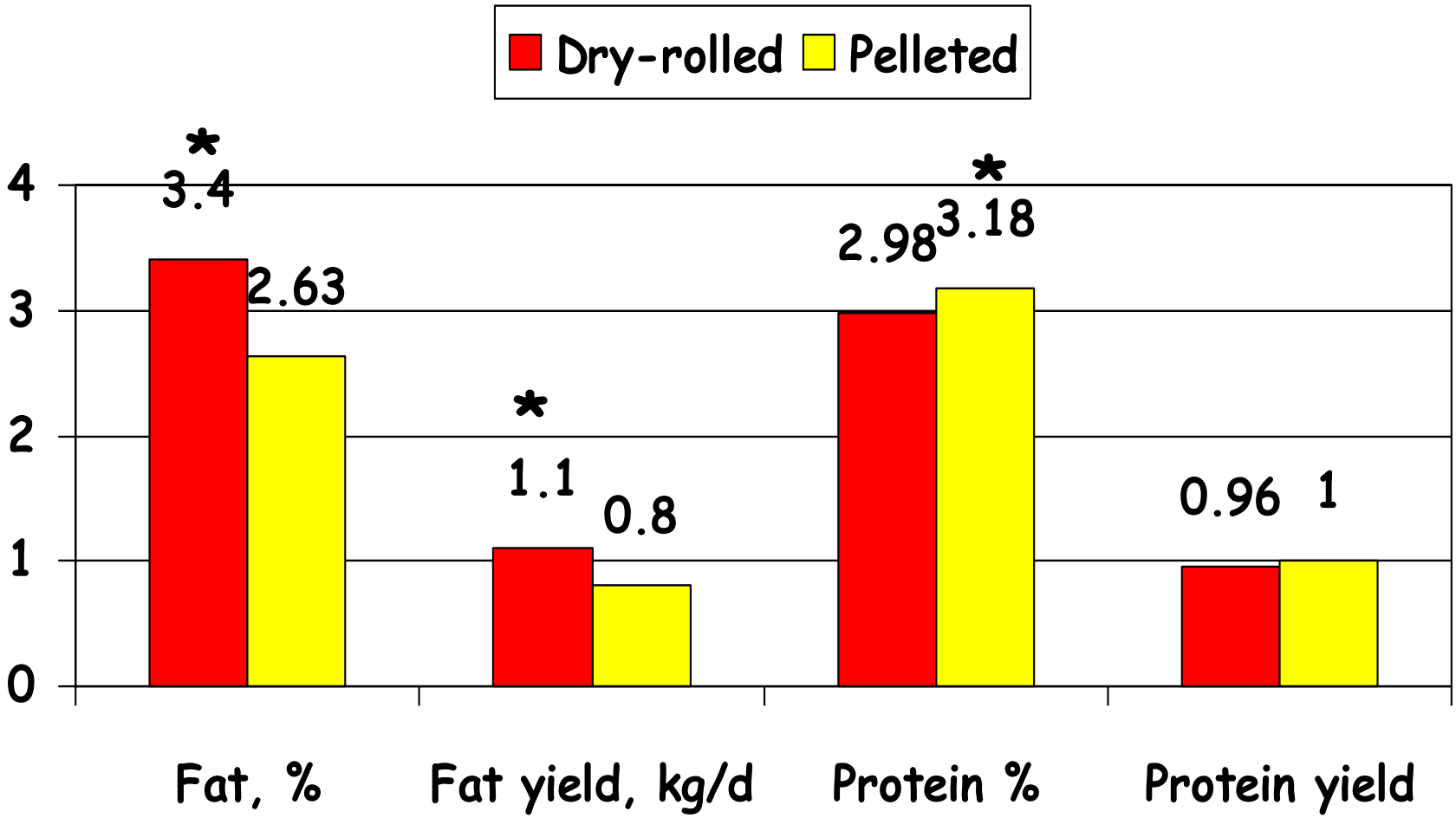
- 2 diets
- Canola meal as major protein source
  - Isonitrogenous, isocaloric
- Dry-rolled barley or pelleted barley
  - Alter available energy in rumen to stimulated MCP
- Rumen- and duodenally-cannulated cows
  - Rumen measurements
  - Duodenal nutrient flow

Effect of Grain Source on Canola Meal Utilization



Gozho et al. 2007

Effect of Grain Source on Canola Meal Utilization



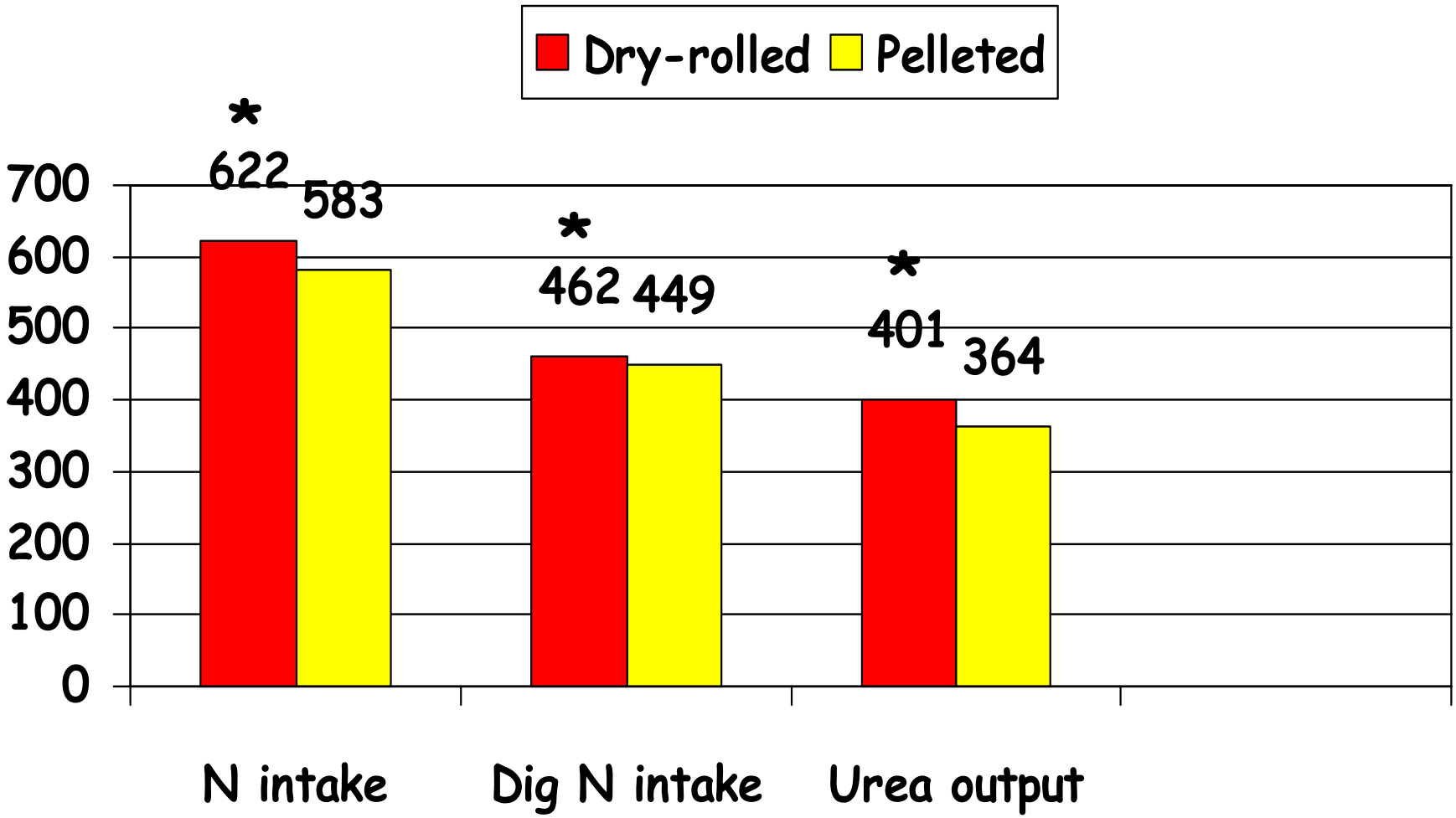
Gozho et al. 2007

Effect of Grain Source on Canola Meal Utilization

	Dry-rolled barley	Pelleted barley
Rumen pH	6.13[a]	5.73[b]
Ammonia, mg/dL	19.9[a]	13.9[b]
Acetate, mM	90.0[a]	74.0[b]
Propionate, mM	31.1[a]	35.7[b]
A:P ratio	3.0[a]	2.4[b]
Butyrate, mM	19.0[a]	15.4[b]
Total VFA, mM	143.3	128.5

Gozho et al. 2007

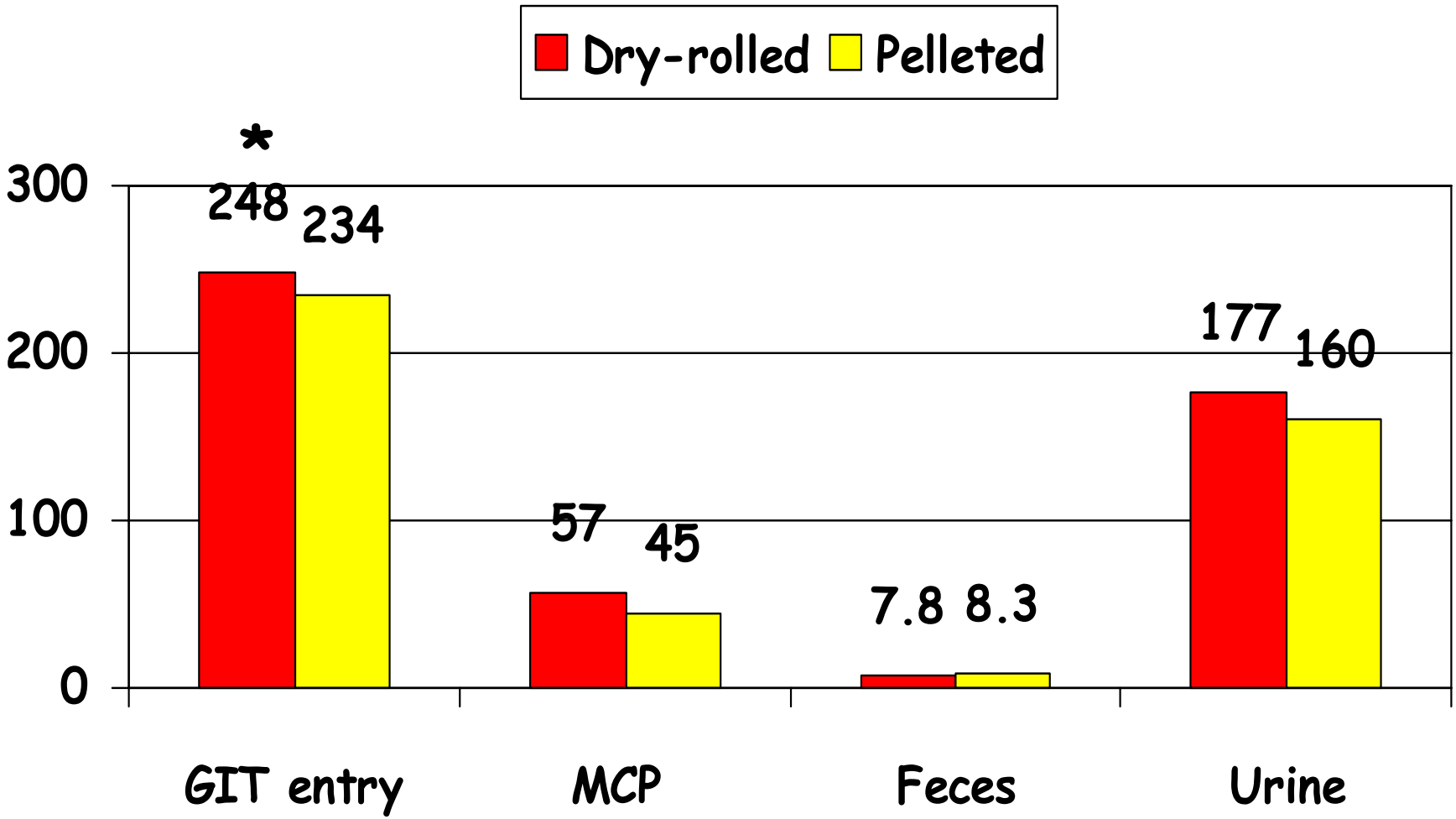
Effect of Grain Source on Canola Meal Utilization



- Urea output: 081-0.84 of digestible N intake

Gozho et al. 2007

Effect of Grain Source on Canola Meal Utilization



- GIT urea entry: 61-65% of endogenous urea production

Gozho et al. 2007

Enhancing Utilization of Canola Meal

- 2 approaches
  - Recapture N as microbial crude protein
  - Rumen protection
    - Physical methods
    - Chemical methods

Production Responses to High RUP Canola Meal

	% CM replaced with heated CM			
Item	0	33	67	100
DMI, lb/d	41	42	44	45
Milk yield, lb/d	64	66	65	70

Rode et al. 1999. J. Dairy Sci. (Suppl. 1):67

Responses to High RUP Canola Meal

	% CM replaced with heated CM			
Daily duodenal flow	0	33	67	100
Feed AA, kg	0.77	0.81	1.02	1.16
Microbial AA, kg	**1.25**	**1.53**	**1.53**	**1.54**
Total AA, kg	2.32	2.72	2.92	3.07
Lysine, g	169	196	215	234
Methionine, g	71	86	99	106

- Is rumen ammonia level limiting MCP production?
  - Uncoupled fermentation?

Rode et al. 1999. J. Dairy Sci. (Suppl. 1):67

Metabolic Trials with Heated Canola Meal

- 2 diets
- Canola meal or heated canola meal as major protein sources
  - Isonitrogenous, isocaloric
- Ruminally- and duodenally-cannulated beef heifers
  - Rumen measurements
  - Duodenal nutrient flow

Ingredients and Chemical Composition of Diets

Item	10% CP		13% CP	
	64.5% RDP	71.0% RDP	64.5% RDP	71.0% RDP
Ingredients, % as fed				
Barley Grain	55.0	55.0	48.0	48.0
Oat Hulls	35.0	35.0	32.0	32.0
Canola Meal	5.0	0.0	8.0	15.0
Heated Canola Meal	0.0	5.0	7.0	0.0
Premix	5.0	5.0	5.0	5.0
Chemical Composition				
DM, %	89.9	88.7	89.8	89.6
CP, % of DM	10.8	10.8	13.9	14.0

K. Baker et al. (unpublished)

N balance in Beef Heifers

Item (g/d)	10% CP		13% CP		SEM	*P* value		
	64.5% RDP	71.0% RDP	64.5% RDP	71.0% RDP		CP	RDP	CP× RDP
DMI, kg/d	8.0	7.5	7.6	7.4	0.5	0.61	0.75	0.51
N balance, g/d								
N intake	138.5	130.1	171.7	165.3	10.8	0.01	0.51	0.93
Fecal N	28.7	26.9	30.3	28.6	2.4	0.50	0.47	0.98
Urine N	50.7	49.0	69.5	72.9	7.7	0.02	0.92	0.75
N retention	59.1	54.2	71.9	63.8	6.0	0.09	0.30	0.79

K. Baker et al. (unpublished)

Urea-N Kinetics in Beef Heifers, g/d

Item	10% CP		13% CP		SEM	*P* value		
	64.5% RDP	71.0% RDP	64.5% RDP	71.0% RDP		CP	RDP	CP× RDP
Urea-N kinetics								
Production	135.0	131.7	165.7	166.9	10.8	**0.03**	0.92	0.84
Gut entry	98.4	93.3	121.1	105.6	11.3	0.81	0.40	0.67
Reabsorbed	70.3	69.8	84.0	86.2	6.5	0.07	0.90	0.84
Feces	2.7	2.6	2.0	2.1	0.2	0.06	0.95	0.68
Urine	36.5	43.1	44.6	61.3	5.1	**0.04**	0.06	0.35
Anabolism (MCP)	25.4	20.9	35.1	17.2	7.7	0.72	0.21	0.43
MCP yield	50.7	55.3	71.0	70.0	15.1	0.27	0.91	0.86

K. Baker et al. (unpublished)

Conclusions

- Canola meal is a premium ingredient for dairy cow rations
  - Superior amino acid profile suited for milk production
- Production responses variable
  - 0.1 to 4.3 kg/d when compared with soybean meal or cottonseed meal
- Feeding value can be enhanced by rumen-protection of canola protein
  - Heat treatment effective
- Need better understanding of protein utilization in rumen and post-ruminally
  - For cows producing >40 kg/d of milk

Financial Support

- Canola Council of Canada
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- Saskatchewan Agricultural Development Fund
- NSERC
- University of Saskatchewan