Feeding Strategies to Reduce N Losses From the Lactating Dairy Cow

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Introduction

1. Dietary Crude Protein Supplies Absorbable Protein
   a. Providing Rumen Degraded Protein (RDP).
   b. Rumen Undegraded Protein (RUP).
2. Complex Relationships Among Diet Composition & Absorbable Amino Acids Supply:
   a. Energy Content Influences Microbial Protein.
   b. RDP & RUP Supplies Influenced by Intake.
   c. Nitrogen (Urea) Recycling to Rumen.

What's Wrong With Feeding Excess Crude Protein

1. Not Economical--Protein Supplements Costl
2. Excretion of N has a Metabolic Cost.
3. N Pollution of the Environment.
4. Increasing Dietary CP Increases Excretion o the Most Labile N.

Effect of Dietary Crude Protein on Milk Yield & Nitrogen Excretion

Some Literature Regarding Dietary [CP]

1. Grings et al. (1991): Milk Yield Increased Linearly fr
   13.8 to 17.5% CP (CSM).
2. Austin et al. (1991) & Akayezu et al. (1997): Protein
   Yield Similar in Cows Fed 16 (+ RUP) & ~18% CP.
3. Powers et al. (1995): Milk Yield, [Protein] at 18% CP
   kg/d, 3.19%) > 14% CP (27 kg/d, 3.14%).

Some Literature Regarding Dietary [CP] (#2)

4. Komaragiri & Erdman (1997): Protein Yield at 19% (1.29 kg/d) > 16% CP (1.15 kg/d).
5. Kalscheur et al. (1999): Yield on 17.4% CP > 15.2% (14 wks); 15.3% CP = 13.3% (19-29 wks).
6. Castillo et al. (2000): Above 15% CP, 67% of the Extr N-Intake is Excreted in Urine.

Protein & Energy Levels (GAB53)

1. 3 Protein Levels; 3 NDF (Energy) Levels at each Protein Level (9 diets).
2. 7-Squares of 9 Cows (63 Total: 45 Multips & 1 Heifers).
3. Incomplete 9x9 Latin square; 4, 4-wk Periods.
4. Yield of Milk & Milk Components; Intake; BV
5. Urine & Fecal Grab Samples.
6. Conservative Stats; e = cow(sq) for CP & NDF

Diet Composition--High NDF

Ingredient	Low CP	Med CP	High CP
		(% of DM)	
Alfalfa Silage	44	44	44
Corn Silage	31	31	31
Rolled HMSC	21	17	13
48% Soybean meal	1.0	5.3	9.8
Roasted soybeans	2.5	2.5	2.5
Sodium Bicarbonate	0.0	0.0	0.0
Minerals & Vitamins	0.4	0.4	0.4
Composition			
Crude protein	15.1	16.7	18.5
AS/Total Forage		59	
NDF		36	
NFC		37	

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Diet Composition--Medium NDF

Ingredient	Low CP	Med CP	High CP
		(% of DM)	
Alfalfa Silage	37	37	37
Corn Silage	25	25	25
Rolled HMSC	31	27	22
48% soybean meal	2.9	7.3	11.8
Roasted soybeans	2.5	2.5	2.5
Sodium bicarbonate	0.3	0.3	0.3
Minerals and vitamins	0.4	0.4	0.4
Composition			
Crude protein	15.2	16.7	18.4
AS/Total Forage		60	
NDF		32	
NFC		41	

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Diet Composition--Low NDF

Ingredient	Low CP	Med CP	High CP
		(% of DM)	
Alfalfa Silage	31	31	31
Corn Silage	19	19	19
Rolled HMSC	42	37	33
48% soybean meal	4.8	9.3	13.7
Roasted soybeans	2.5	2.5	2.5
Sodium bicarbonate	0.6	0.6	0.6
Minerals and vitamins	0.4	0.4	0.4
Composition			
Crude protein	15.1	16.6	18.3
AS/Total Forage		61	
NDF		28	
NFC		46	

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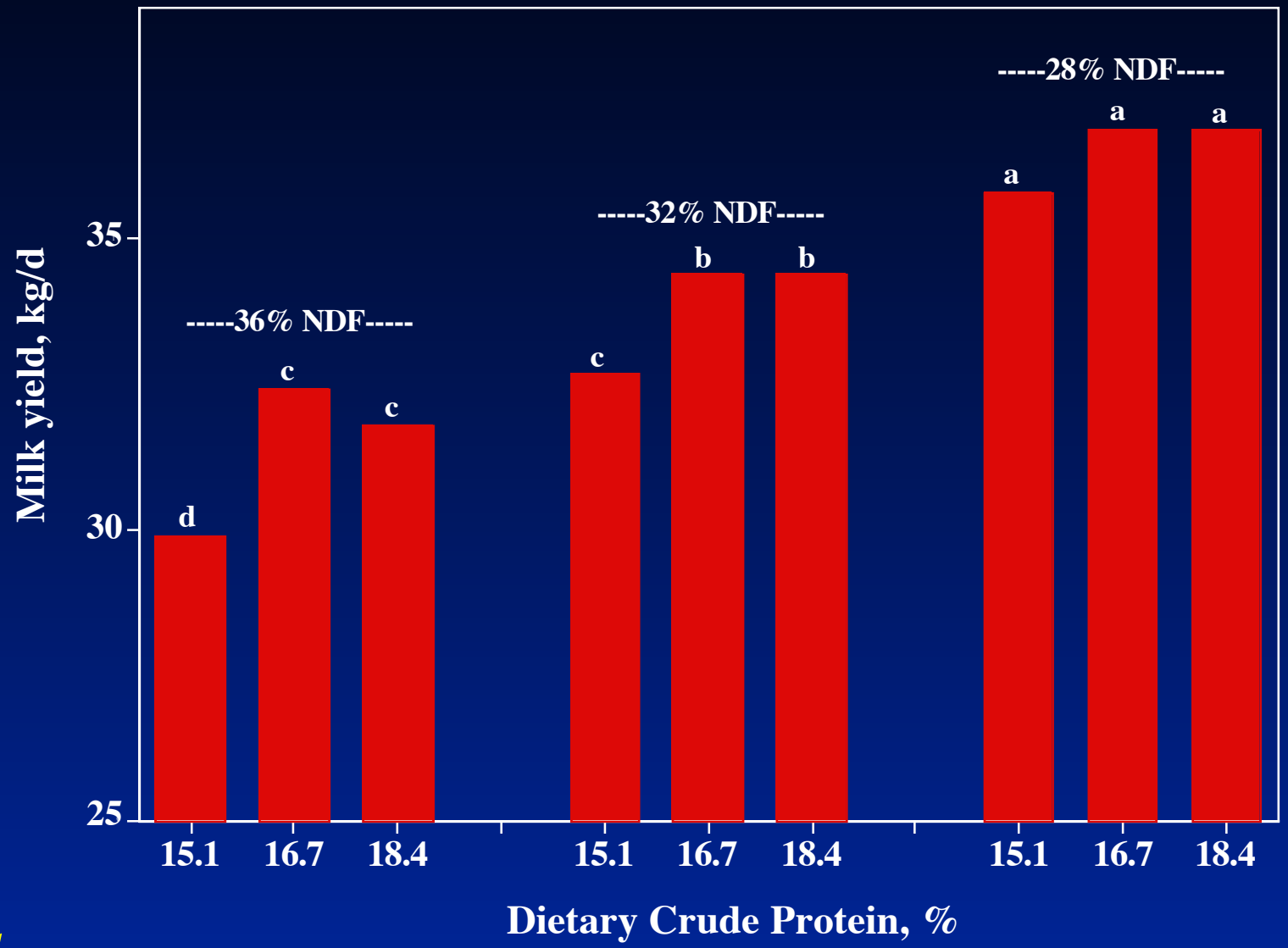
Production--CP Levels

Ingredient	15.1% CP	16.7% CP	18.4% CP	Linear P
DMI, kg/d	21.1	22.3	22.6	0.03
Milk, kg/d	32.8	34.6	34.4	0.48
Fat, kg/d	1.15	1.24	1.20	0.33
Protein, kg/d	0.98	1.03	1.02	0.46
SNF, kg/d	2.95	3.06	3.06	0.62
MUN, mg/dL	9.2	12.4	16.0	< 0.01
Milk N/N Intake	0.31	0.28	0.25	< 0.01
Urinary N, g/d	119	169	227	< 0.01
Fecal N, g/d	231	264	278	0.04

Production--NDF Levels

Ingredient	36% NDF	32% NDF	28% NDF	Linear P
DMI, kg/d	21.7	22.1	22.1	0.84
BW gain, kg/d	0.39	0.47	0.71	0.02
Milk, kg/d	31.4	33.8	36.5	< 0.01
FCM, kg/d	33.0	34.8	34.4	0.32
Fat, kg/d	1.20	1.24	1.15	0.48
Protein, kg/d	0.92	1.01	1.10	< 0.01
True protein, kg/d	0.85	0.94	1.03	< 0.01
MUN, mg/dL	13.3	12.7	11.5	< 0.01
Milk N/N Intake	0.26	0.27	0.30	< 0.01
Urinary N, g/d	182	175	158	0.10
Fecal N, g/d	253	259	262	0.64

Effect of Diet on Milk Yield (GAB53)



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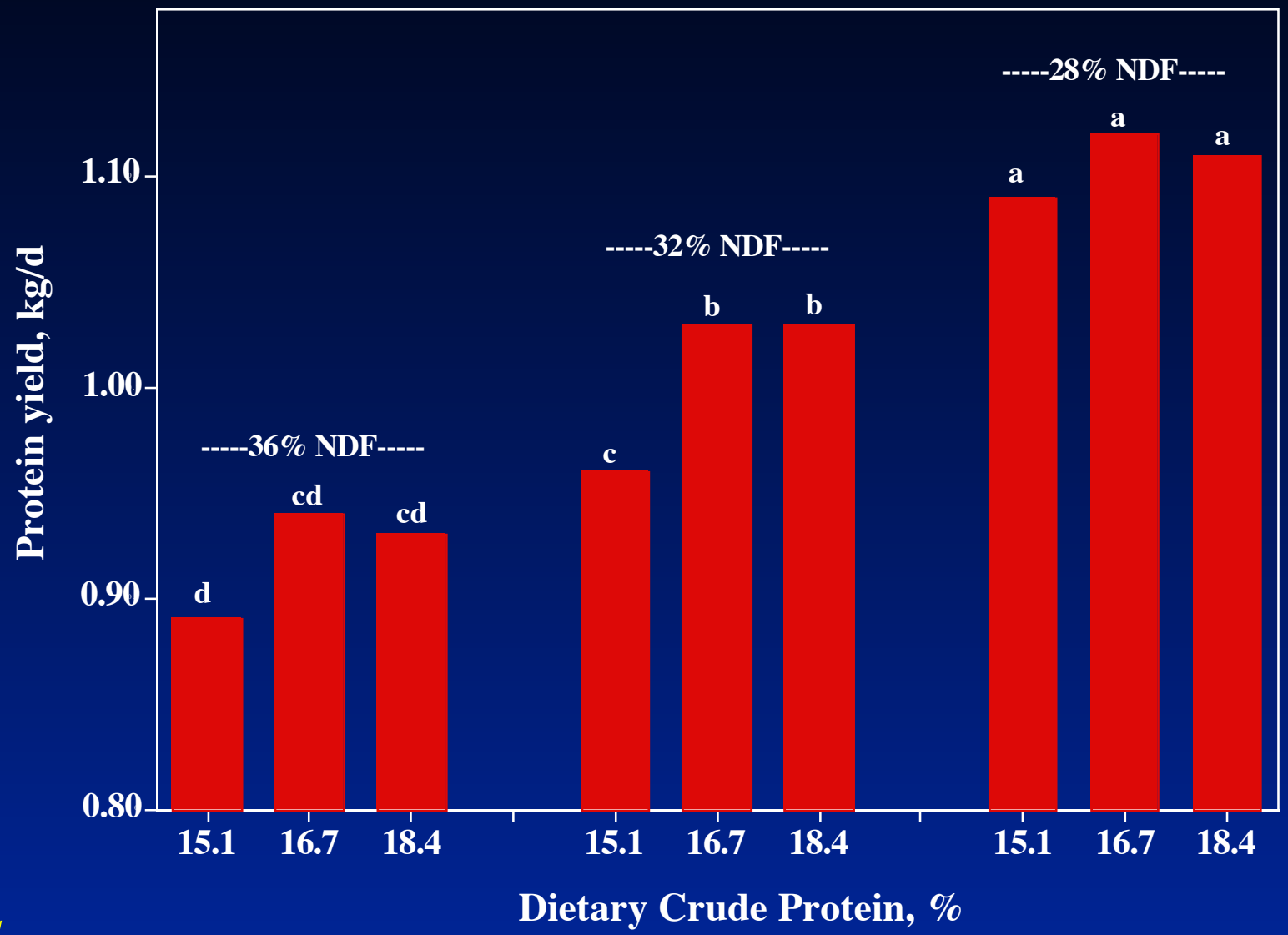
Effect of Diet on Protein Yield (GAB53)



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Approaches to Reducing Dietary CP

1. Accurate Tracking of Dietary CP Intake (MUN?).
2. Feed Hay Rather Than Silage.
3. Reduce NPN in Hay-Crop Silage.
4. Dilute Hay-Crop Silage with Corn Silage.
5. Feed More Concentrate (as Much as Possible?).
6. Match CHO & CP Fermentation.
7. Feed By-Pass Protein & Essential AA.
8. Use "N-Free" Essential AA (eg, MHA).

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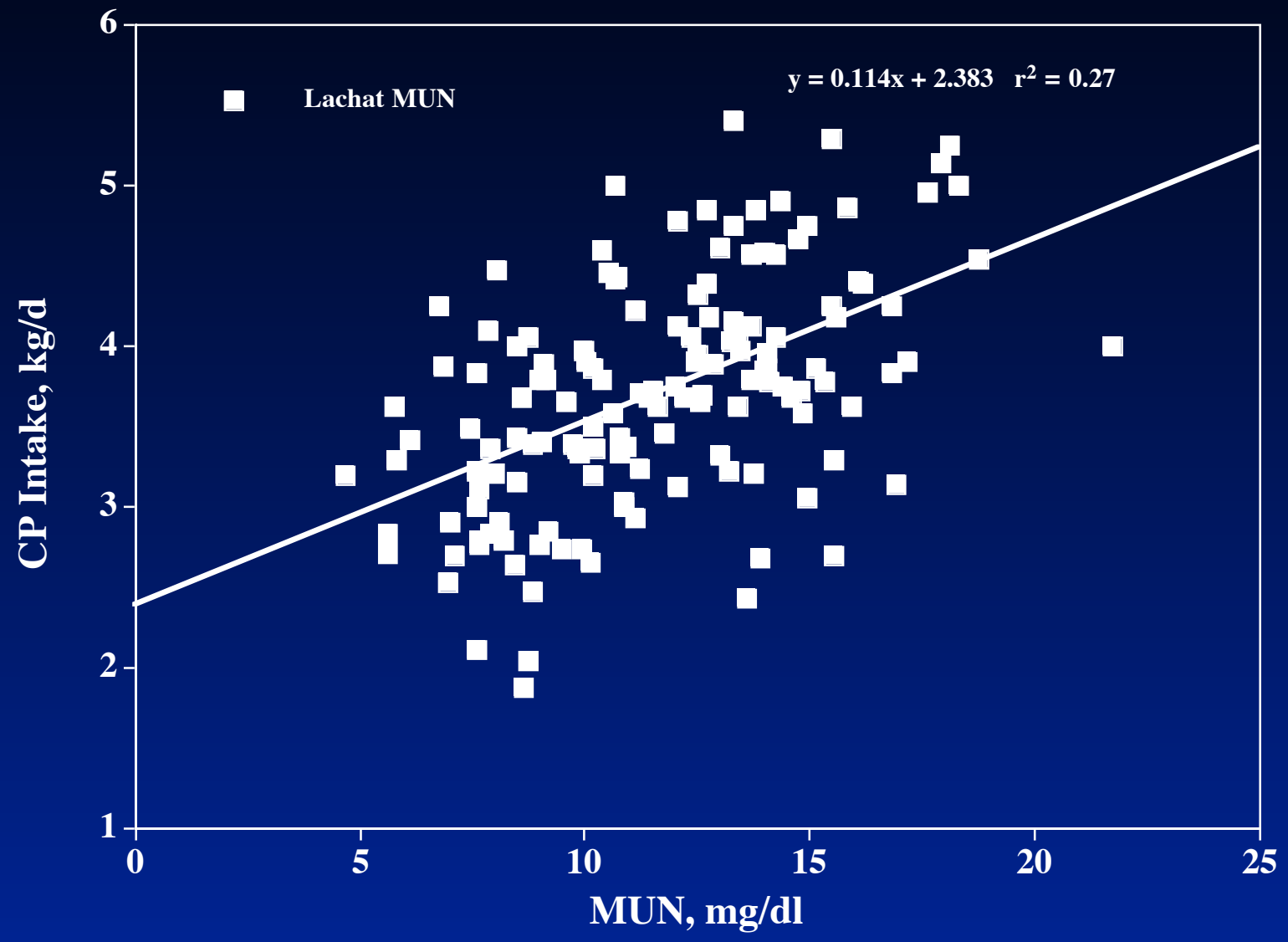
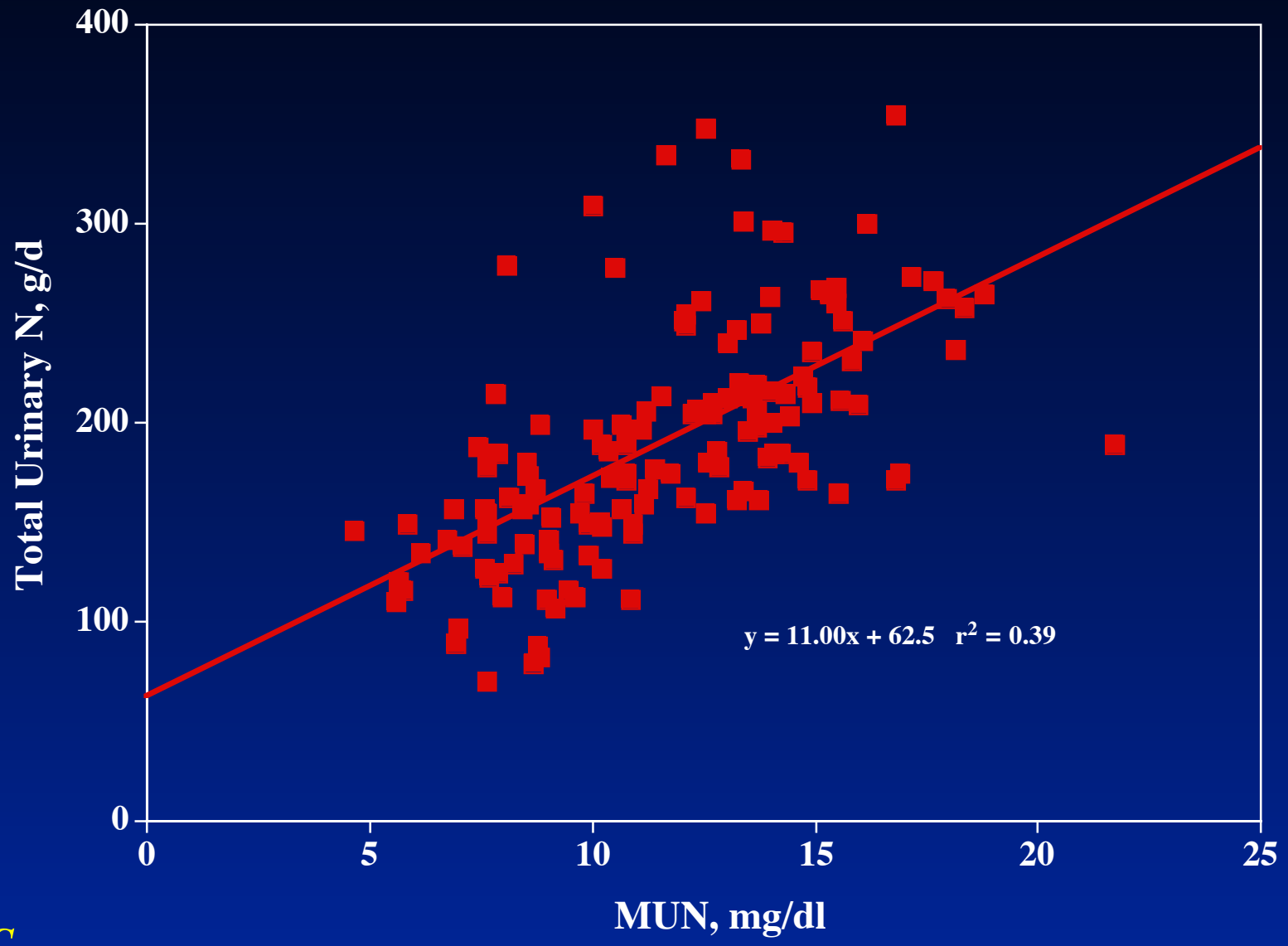
Single Factor Regressions on Milk Urea N (MUN) Using Mixed Effects Models (Broderick & Clayton, 1997)

Factor	Equation	ddf	I
CP, % of DM	Y = 0.269 MUN (mg/dl) + 13.7	479	0.
Rumen NH_3-N, mg/dl	Y = 0.686 MUN (mg/dl) + 6.43	205	0.

Relationship of CP Intake & MUN (GAB53)



Relationship of Urinary N to MUN (GAB53)



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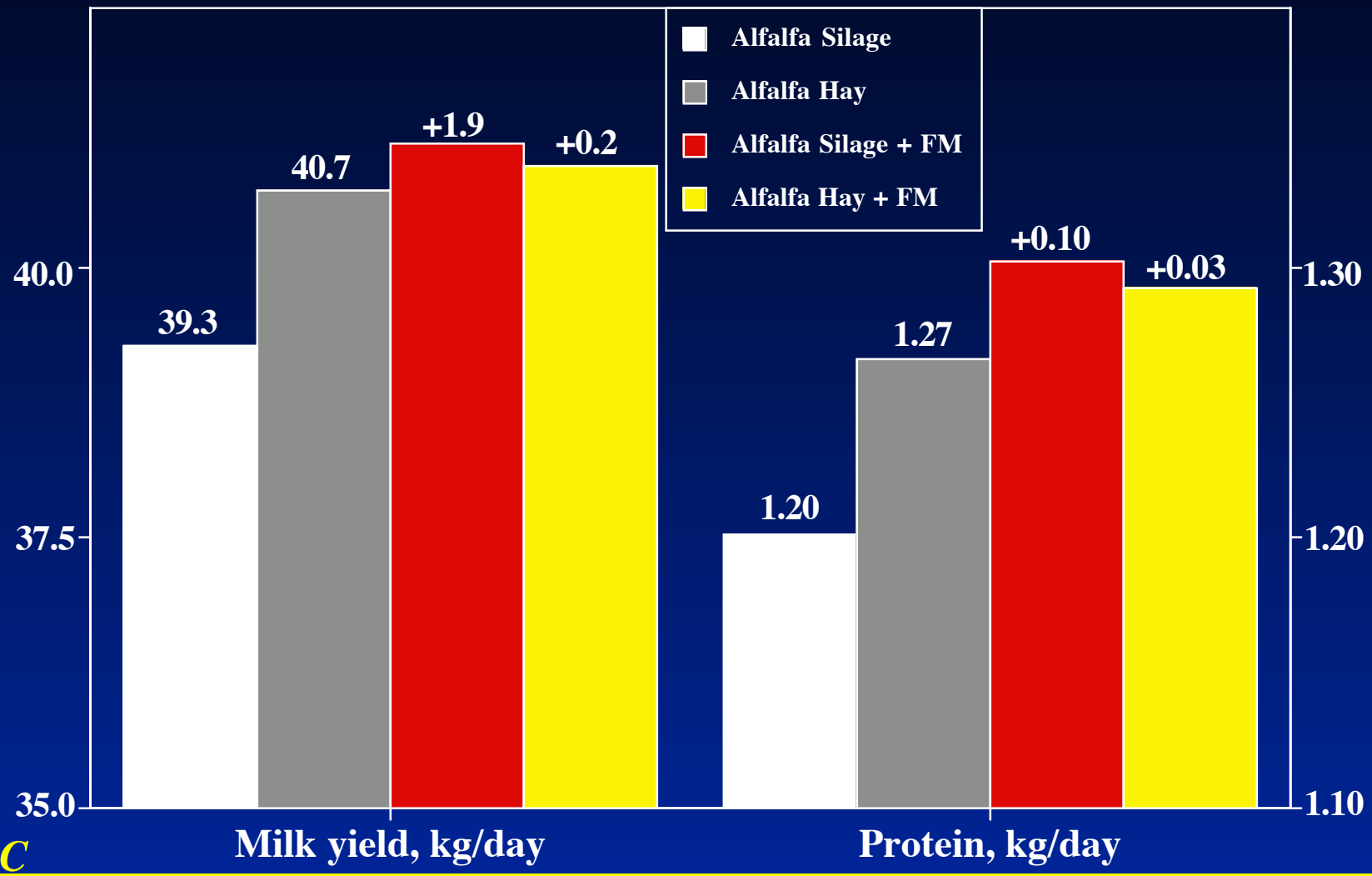
Effect of Fish Meal (FM) Supplementation of Diets with 50% Alfalfa Silage or Hay (Vagnoni & Broderick, 1997



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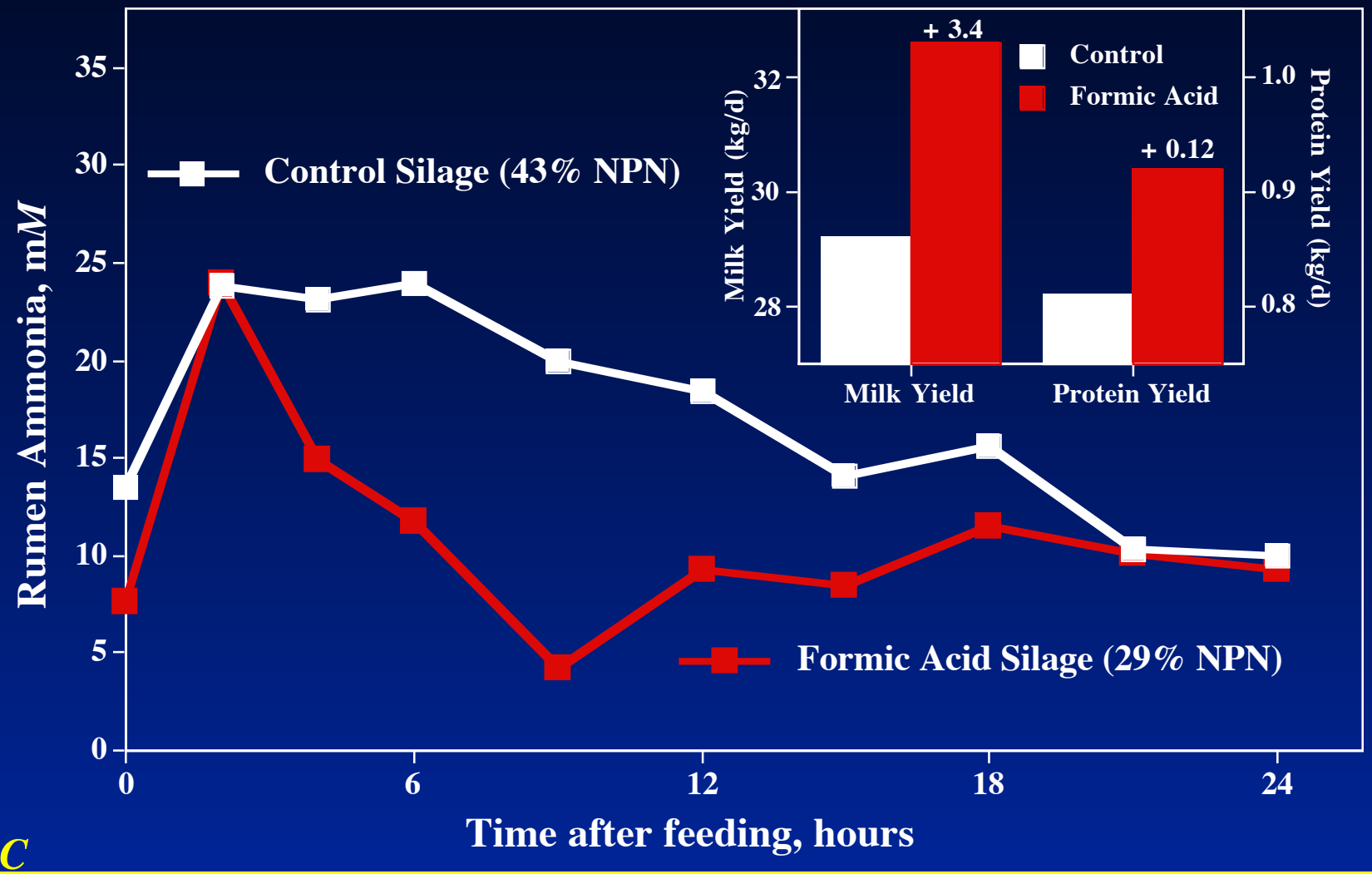
Reducing NPN in Alfalfa Silage Reduces Excess Rumen Ammonia & Improves Milk Production

(Nagel & Broderick, 1992)



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Milk Yield of Cows fed Forage as Alfalfa Silage or Alfalfa + Corn Silage Mixtures (Dhiman & Satter, 1998)

Item	Forage Source		
	AS	2/3 AS:1/3 CS	1/3 AS:2/3 CS
Composition (% of DM)			
Alfalfa Silage	50.0	33.3	16.7
Corn Silage	0.0	16.7	33.3
Conc. Mix	50.0	50.0	50.0
Crude Protein	18.6	17.5	16.6
NEL (Mcal/kg DM)	1.69	1.69	1.69
Production (kg/305 d)			
Milk (Multiparous)	9,570[b]	10,160[a]	10,020[ab]
Ruminal NH_3 (mM)	12.3[a]	10.5[b]	9.4[c]

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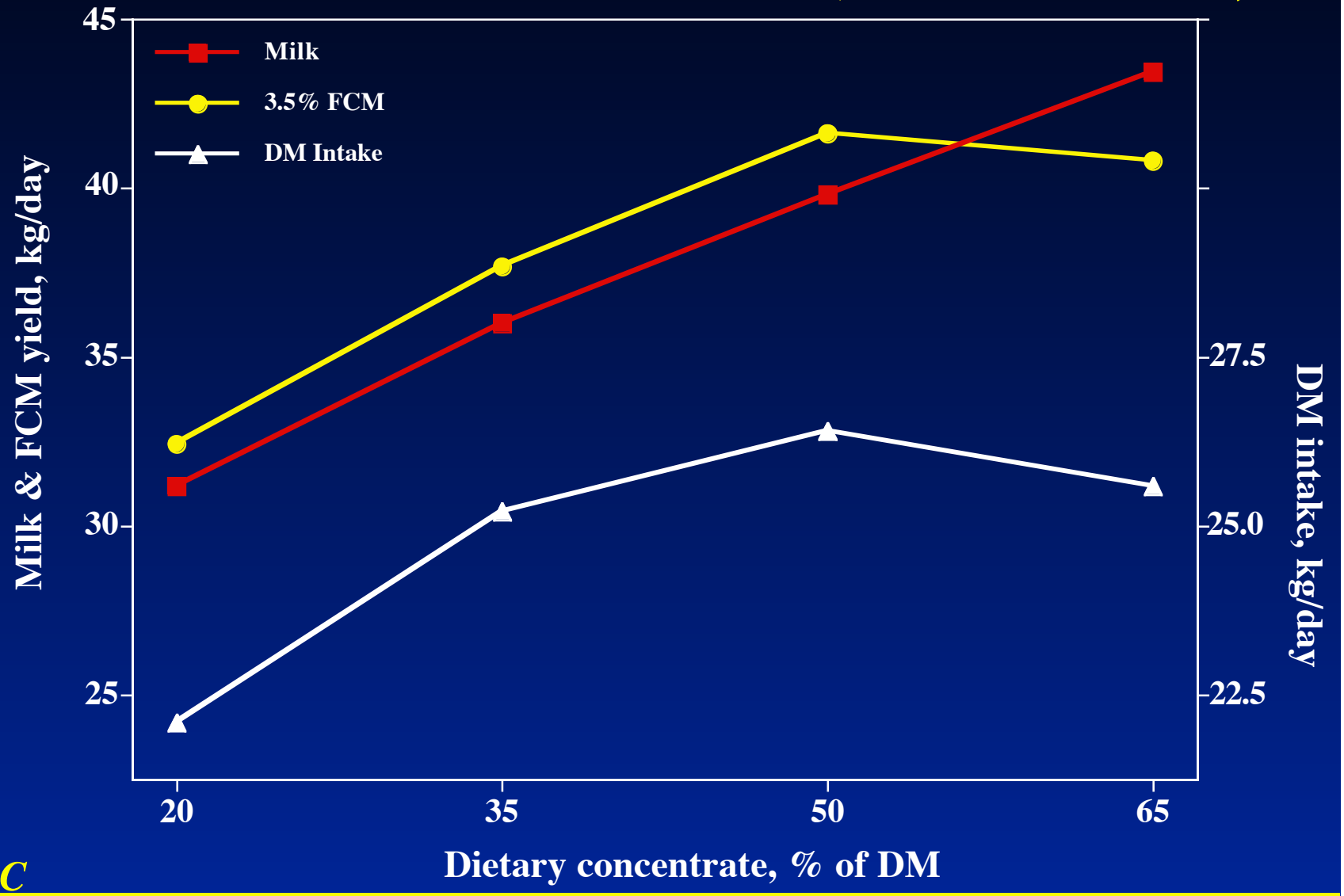
Concentrate Supplementation of Alfalfa Silage & DM Intake & Milk Yield (Valadares et al., 2000)



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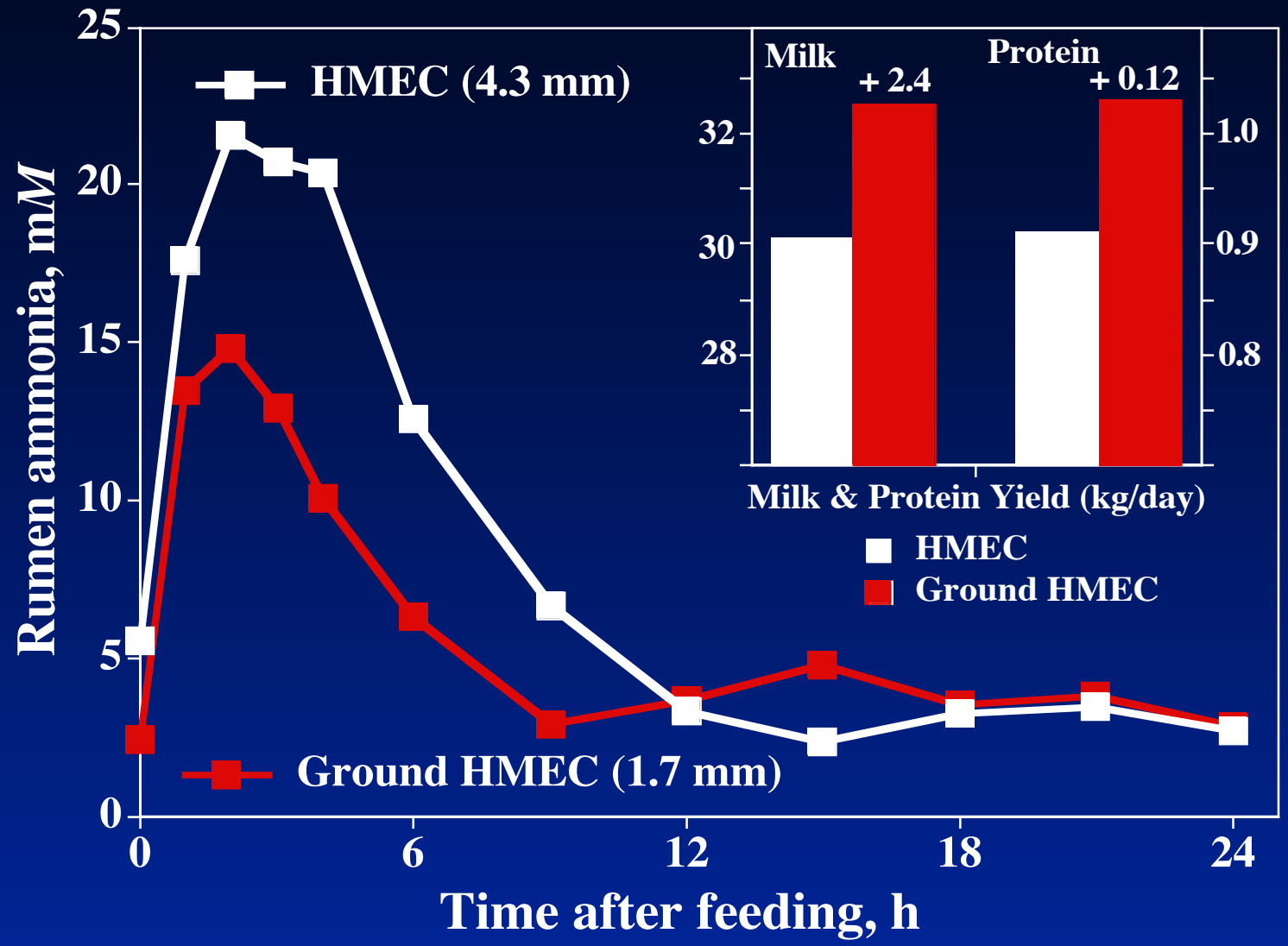
Rumen NH_3 & Production of Cows fed Alfalfa Silage & Ground HMEC (Ekinci & Broderick, 1997)



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Effect of Replacing Starch with Sugar

Variable	Added Sugar 0.0%	2.5%	5.0%	7.5%	Diet P
DMI, kg/d	24.5	25.6	26.0	26.0	0.01
Milk, kg/d	38.9	40.4	40.0	39.4	0.7
FCM, kg/d	40.5	42.2	43.9	43.2	0.1
Fat, %	3.81	3.82	4.07	4.16	0.01
Fat, kg/d	1.47	1.53	1.65	1.62	0.05
$MUN_{(as)}$, mg/dl	11.0	10.3	10.8	10.3	0.1
Rumen NH_3N, mg/dl	6.9	6.8	6.2	5.8	0.1
Rumen BCVFA, %	3.7^{a}	3.3^{a}	3.1^{ab}	2.4^{b}	0.02

$^{ab}(P < 0.05)$

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Rumen-Protected (RP) Lys (40 g/d) & Met (15 g/d) & Milk Yield in Lactating Cows (Donkin et al., 1989)

Milk Component	Control	RP-Lys + Met	Prob.
Milk (kg/day)	25.3	26.3	> 0.10
Protein (kg/day)	0.80	0.86	< 0.10
Protein (%)	3.15	3.25	< 0.01
Casein (%)	2.92	3.05	< 0.01

Variable Response with Rumen Protected Met + Lys

1. <u>Piepenbrink et al. (1996):</u> No Improvement in Milk & Protein Yield.
2. <u>Armentano et al. (1997):</u> Improved Protein Yield (60g/d) w/ Met, Not Lys.
3. <u>Dinn et al. (1998).</u>

Dilution of Dietary CP w/ RP-AA (Dinn et al., 1998)

Ingredient	15.3% CP	16.7% CP	18.3% CP
RP-Met, g/d	7.2	10.9	. . .
RP-Lys, g/d	7.5	6.0	. . .
DMI, kg/d	22.1[b]	22.3[b]	23.7[a]
Milk yield, kg/d	32.8[b]	32.8[b]	34.2[a]
Milk N, % N intake	33.1[a]	29.3[b]	25.8[c]
Urinary N, kg/d	0.162[c]	0.195[b]	0.264[a]
Fecal N, kg/d	0.151	0.155	0.158

(diets = 33% NDF)

[abc]($P < 0.05$)

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8. Use "N-Free" AA (eg, MHA; BC-VFA).

Liquid MHA (Alimet; "N-Free" AA)

1. Koenig et al. (1999): 50% MHA Escaped.
2. Stephenson et al. (1990): Small Wool Growth Response w/ fed MHA (20% of Abomasal MHA).
3. Future Use of RP-MHA or RP-AA C-Chains?

Feeding Branched-Chain VFA

1. Isobutyrate, Isovalerate, 2-Methyl Butyrate Used b
   Some Rumen Bacteria to Form BC-AA.
2. Rogers et al. (1989): BC-VFA Increased Milk Yield
   in Early Lactation on 43 Commercial Dairies.
3. Otterby et al. (1990): BC-VFA (0.8% of Diet)
   Increased Milk Yield in Mid- & Late-Lactation.
4. Johnson et al. (1994): No Effect of BC-VFA on Mil
   Yield (But a + Effect of RUP).

Feeding Less Total Crude Protein

1. Increase Profitability & Reduce N-Pollution.
2. Produce "Better" Manure (eg, More Fecal-N).
3. Protein Needed to Feed N to Rumen, EAA to Cow.
4. Protein Needed to Optimize Feed Intake.
5. 16.5% CP Satisfactory; "Safety Margin" Problem.
6. Can We Feed 15% CP & Maintain Production?