Amino Acid Supply in the Ruminant

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VirginiaTech
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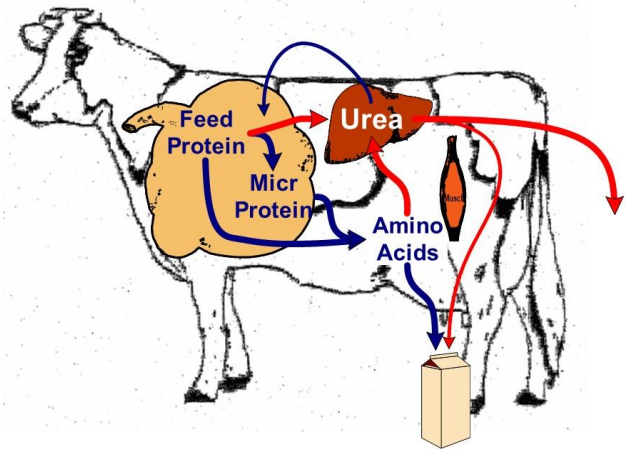
N and Amino Acid Supply in Ruminants

DAIRY SCIENCE



- Nutrient Intake
- Ruminal Metabolism
  - Escape to SI
  - Capture in Micr
  - Fermentation to other products
  - Absorption
- Abomasum/SI
  - Digestion
  - Absorption
- Large Intestine
  - Digestion
  - Fermentation
  - Absorption

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Integrated Milk Protein Predictions

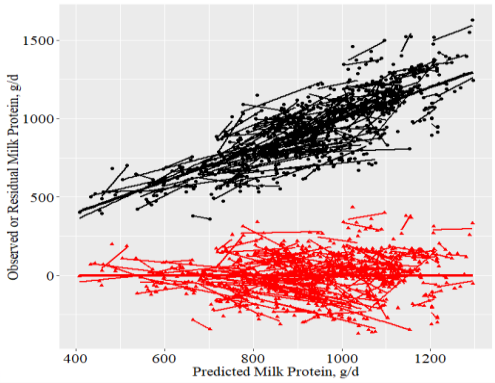
$$mPrt = \beta His + \chi Ile + \delta Leu + \varepsilon Lys + \phi Met + \varphi Thr + \lambda DEI + \kappa dNDF + \mu BW + \lambda(\sum EAA^2)$$

Predictors	Intercept	His	Ile	Leu	Lys	Met	Thr	∑(EAA²)	DEInp	dNDF	BW
	g/d	---------- g/g ----------							g/mcal	g/%	g/kg
Estimates	6.3	**2.44**	**1.05**	**0.99**	**1.10**	**1.80**	**2.01**	**-0.0025**	**9.27**	**-3.37**	**-0.26**
SE	102	0.76	0.51	0.29	0.30	0.39	0.75	0.0004	0.68	0.94	0.14

Cross Evaluation Results – 500 Iterations

Variable	Mean	SE
Observed Mean, g/d	924	17
Predicted Mean, g/d	924	13
RMSE	126	7
RMSE, % mean	**13.7**	**0.8**
Mean Bias, % MSE	0.7	0.9
Slope Bias, % MSE	2.8	2.4
CCC	0.78	0.03

- Arg significant but variable
- Trp, Phe, and Val → inadequate data



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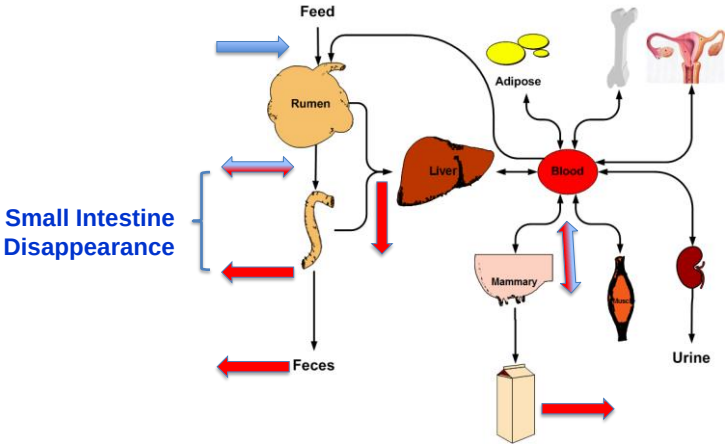
Amino Acid Supply Methods

Identity Preservation??



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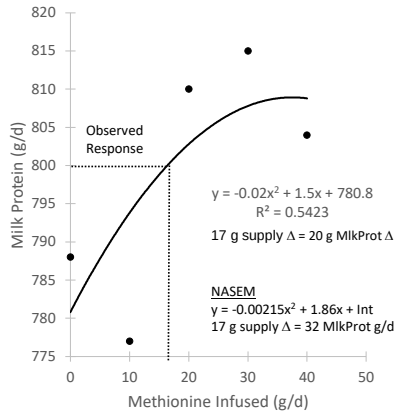
Milk Protein Yield Response

Varvikko et al., 1999



- Net delivery to milk from:
  - Infused vs ingredient
- Develop a milk response curve
  - SE_{STD_Curve} = 13.5 g/d
- Include 1 or more Ingr Eval Trt
  - SEM for single point = 20 to 40 g/d
  - 20 g error = 30 g Δ in Met Supply
  - Min Δ Met for STD Curve ≈ 80 g/d
  - Min Sample Δ = 60 g/d
  - Expect 30% SE on Bio Estimate
- Infusion site?
  - Gut
    - replicates dRUP
    - Absorptive losses = 5-15%
  - Jugular
    - Misses loss during absorption

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Blood Concentration Responses

Dietary MP = 115% of Requirement

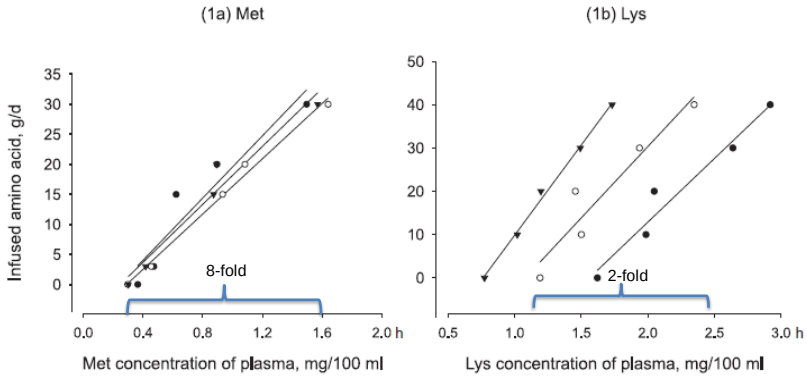

Figure 1. Individual variations of relationships between plasma of Met (1a) or Lys (1b) and amounts infused into the duodenum. Milk protein yield of cows: ● Cow 1 = 189 g/d; ○ Cow 2 = 249 g/d; ▼ Cow 3 = 358 g/d

Rulquin, H. and J. Kowalczyk. 2003

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Blood Concentration

Rulquin, H. and J. Kowalczyk. 2003.

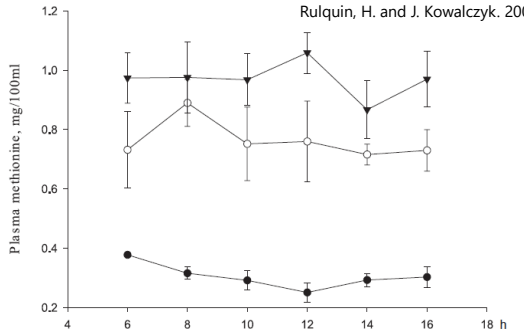

Figure 2. Diurnal variations of plasma methionine concentrations of cows supplied with graded doses of Smartamine ML™: —●— 50 g SmartamineML™, —○— 88 g SmartamineML™, —▼— 132 g Smartamine ML™

Methionine and lysine bioavailability in Smartamine M™ and Smartamine ML™

Indices	Smartamine M™		SED	Smartamine ML™			SED
Product, g/d	30	40		50	88	132	
Met, g/d	23.4	31.2		8.4	14.8	22.2	
Lys, g/d				19.7	34.7	52	
Bioavailability, %							
Met	75.1	75.1	3.43	95.3	79.7	77.7	10.5
Lys				106.3	84.0	109.3	18.2

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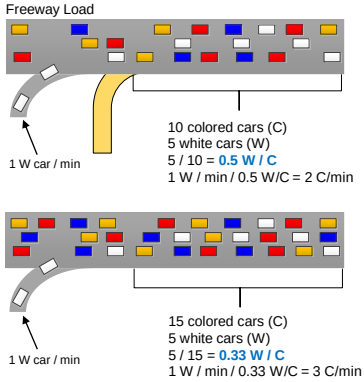
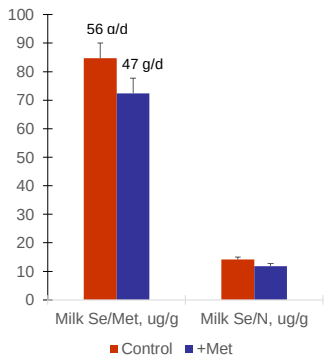
Efficacy by Dilution

Freeway Load



Challenges
- Need constant clearance of marker
- Loss of label via alternative exit and alternative entry points
- Se specific to Met

Infused 9 g Met
12.2 mg Se/g / 84.7 = 14.4% change in Met supply
SEM = 5.3 mg/g =43% SE



Weiss and St-Pierre, 2009

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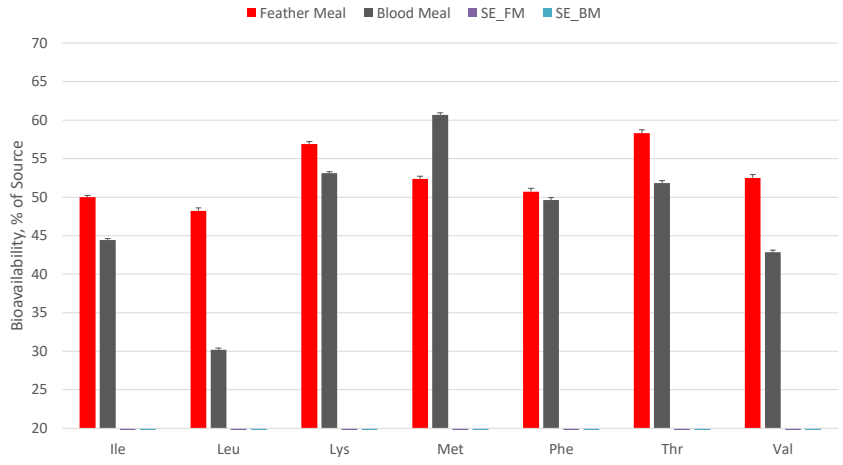
Ingredient EAA Bioavailabilities



Estes et al., 2018

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Stable Isotope Results – Prestegaard and Fernandes (Virginia Tech)

RP-AA	Plasma Appearance (%)[1]	Bioavailability (%)[2]
AminoShure®-XM	51.2	55.0
RP-Lysine Prototype 1	59.8	64.0
RP-Lysine Prototype 2	44.0	47.1
RP-Histidine Prototype 1	68.7	73.5
RP-Histidine Prototype 2	51.9	55.6

[1]Percent of AA appearance in plasma. Calculated as the grams of AA absorbed into blood per 100 grams of AA fed
[2]Predicted bioavailability corrected for 7% loss during first pass

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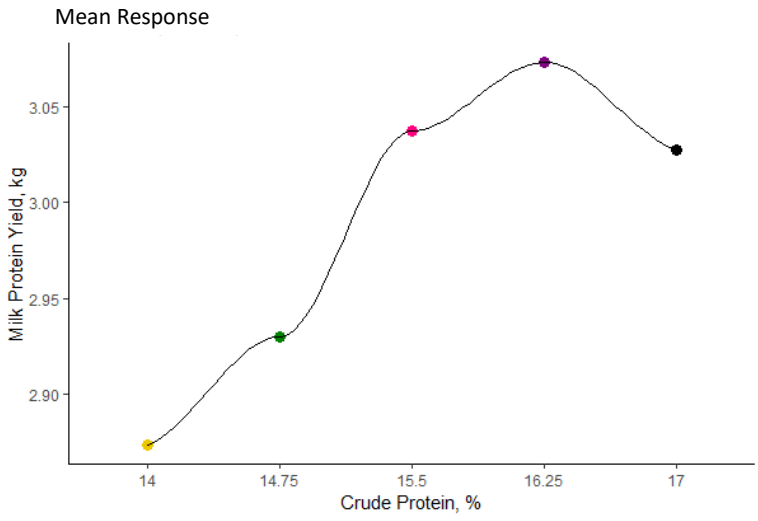
Within Cow Milk Protein Responses to MP



Campos et al., in progress
VT/Univ. Tn. Collaboration

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Conclusions

- Several Valid Methods of Assessment
- Variance is not equal across methods
  - Reduced by greater Ingr feeding and replicating observations
  - Milk Protein Response
    - ± 30% if 90 g Met/d fed
    - Double Lys fed for similar error
  - Blood Concentrations
    - ± 12% units for Met at 100 g/d
    - ± 18% units for Lys
    - e.g. 70% bioavailabilty ± 18%
  - Se-Met Dilution
    - ± 15% units
    - Met only
  - Isotope Dilution
    - ± 12% Units
    - All EAA

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