Amino Acid Supply in the Ruminant

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Ohio Dairy Nutrient Values – 5-year Average

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Nutrient values derived using Sesame
Buckeye Dairy News: Vol 22, Issue 2 (March, 2020)

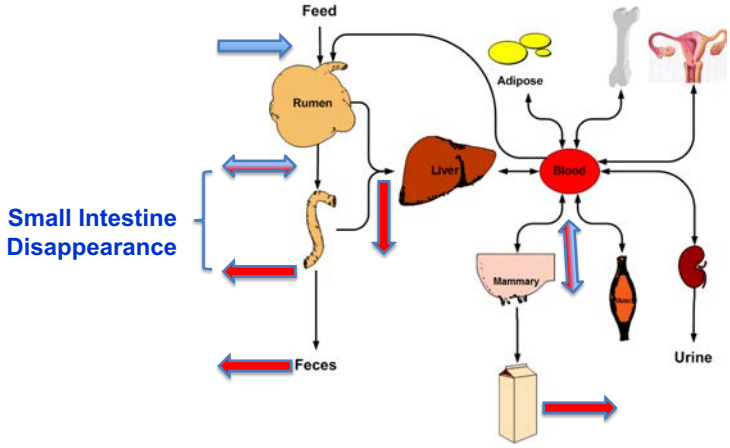
Nutrient	Cost/Unit	Daily Supply*	Cost/cow /d
NEL (3X, NRC 2001) MCal	$0.08	35.4 Mcal	$2.83
Metabolizable Protein (NRC) Lbs	$0.43	5.44 lbs	$2.34
Effective NDF (forage NDF) Lbs	$0.14	10.4 lbs	$1.46
Non-effective NDF (Total NDF – Forage NDF) Lbs	-$0.02	7.3 lbs	-$0.15
Total Cost for Energy, Protein and Fiber			$6.48

* 1600 lb cow, 80 lbs milk/d, 3.0% protein, 3.5% fat

https://dairy.osu.edu/newsletter/buckeye-dairy-news/volume-22-issue-2/milk-prices-costs-nutrients-margins-and-comparison
Sesame can be licensed and used for local markets

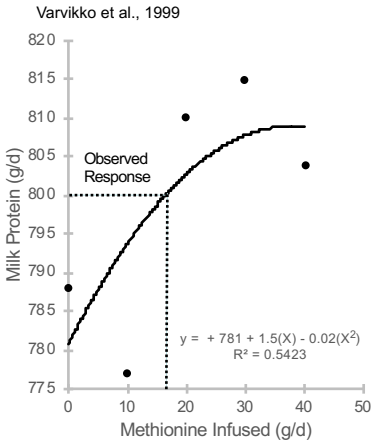
Amino Acid Supply Methods

Identity Preservation??



Efficacy by Milk Protein Response - $$$$

Supply and Requirement Knowledge



20 g protein response = 17 g supply change

- Net delivery to milk
  - Compare RPAA to infused crystalline
- Challenges
  - Precision not high
  - Will the cows be responsive?
    - Requirement knowledge is ↓
  - Absorbed→ milk efficiency varies
    - Infused and RPAA must be similar
  - Infusion site?
    - Gut: does RPAA Abs loss = crystalline AA loss??
    - Jugular: miss losses during absorption

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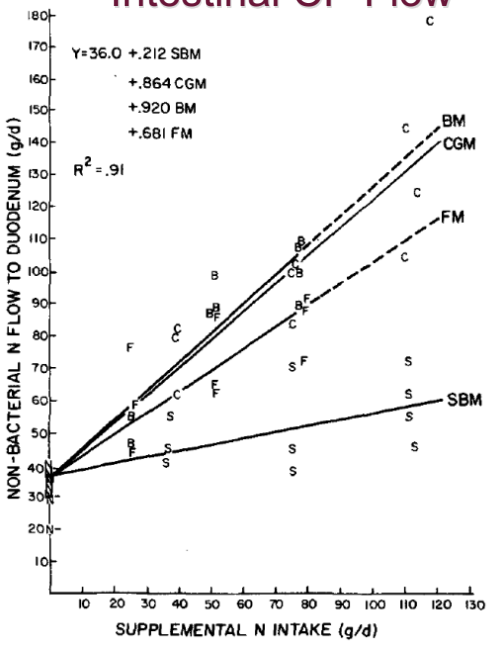
Intestinal CP Flow - $$$$



6 to 10% variation in CP flow ☺

Protein Source	SE
Soybean Meal	0.059
Corn Gluten Meal	0.058
Blood Meal	0.086
Fish Meal	0.095

Titgemeyer et al., 1989

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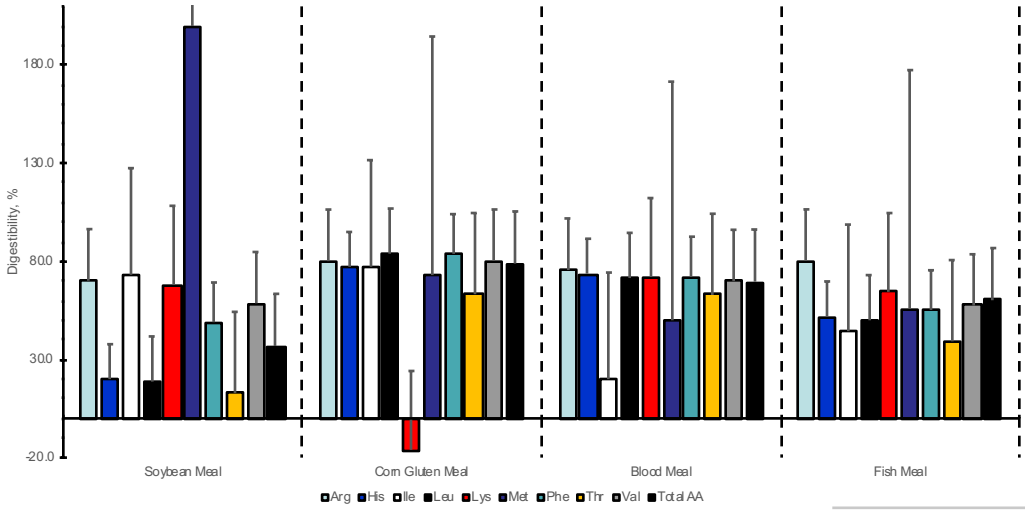
Intestinal AA Digestibility: 25-50% Variation



Titgemeyer et al., 1989

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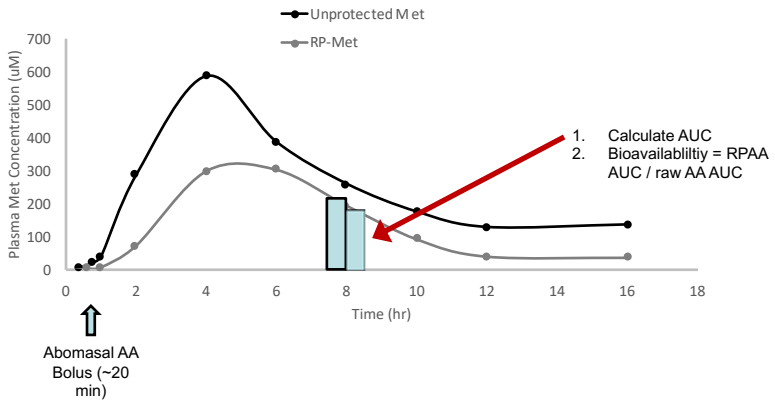
Efficacy by In Situ + Abomasal Infusion - $

RP-Met



Challenges

- Unprotected [AA] ~ [RPAA]
  - Large differences may cause changes in use
- Abomasal value should be absolute but In Situ is a relative measure
- ∴ relative efficacy

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Blood Concentration Responses - $$$$

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Dietary MP = 115% of Requirement

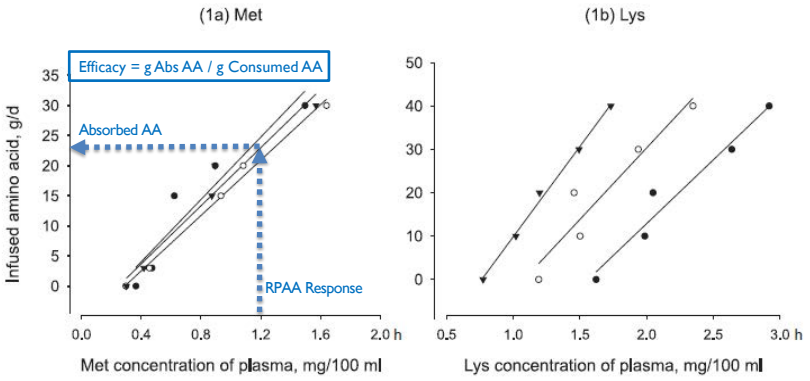

Figure 1. Individual variations of relationships between plasma of Met (1a) or Lys (1b) and amounts infused into the duodenum. Milk protein yield of cows: ● Cow 1 = 189 g/d; ○ Cow 2 = 249 g/d; ▼ Cow 3 = 358 g/d

Rulquin, H. and J. Kowalczyk. 2003

Abomasal Availability of Encapsulated Lys and Met

Multi-point Standard Curve

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

Rulquin, H. and J. Kowalczyk. 2003

Lysine prototype bioavailability.

Calculated within Animal	Bioavailability (%)	SE
Encapsulate 1	**48***	**16**
Encapsulate 2	**58*[a]**	**16**
Encapsulate 3	**22[a]**	**20**

* Significantly different from 0, $P<.05$.
[a] Encapsulate 2 and 3 trended towards a difference ($P<.12$)

Hanigan et al., unpublished

- Multi-point Std Curve
- Single-point comparisons will have greater variance

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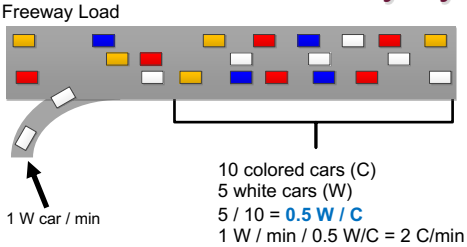
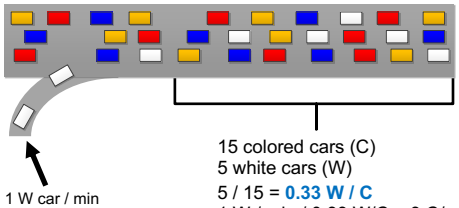
Efficacy by Dilution - $$

Freeway Load



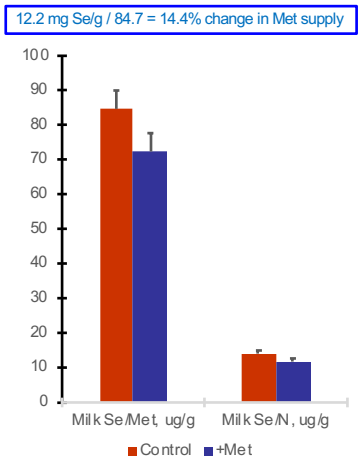
1 W car / min

10 colored cars (C)
5 white cars (W)
5 / 10 = **0.5 W / C**
1 W / min / 0.5 W/C = 2 C/min



1 W car / min

15 colored cars (C)
5 white cars (W)
5 / 15 = **0.33 W / C**
1 W / min / 0.33 W/C = 3 C/min



Weiss and St-Pierre, 2009

Challenges
- None provided constant clearance of marker
- Se specific to Met

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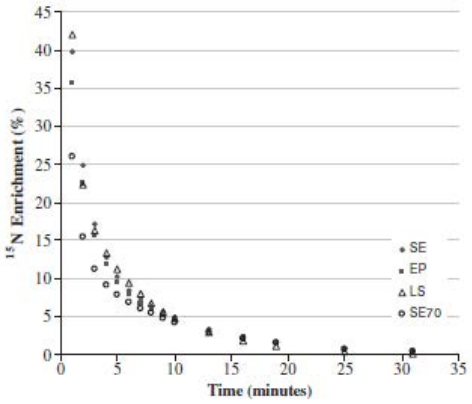
^{13}C-Amino Acid Dilution

- Borucki Castro et al. (2008)
  - Lys digestibility of differing SBM
- Bolus infusion has challenges
  - ~30 min clearance → extrapolate to 24 h
  - 2 decay slopes
    - movement into extracellular and cellular space
    - Clearance by cellular metabolism
- Constant infusions
  - Isotope sequestration in body protein
  - 36+ h to label most body protein → $$
  - Model body protein turnover → ↓$$, ↑ math



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AA Absorption from various Ingredients

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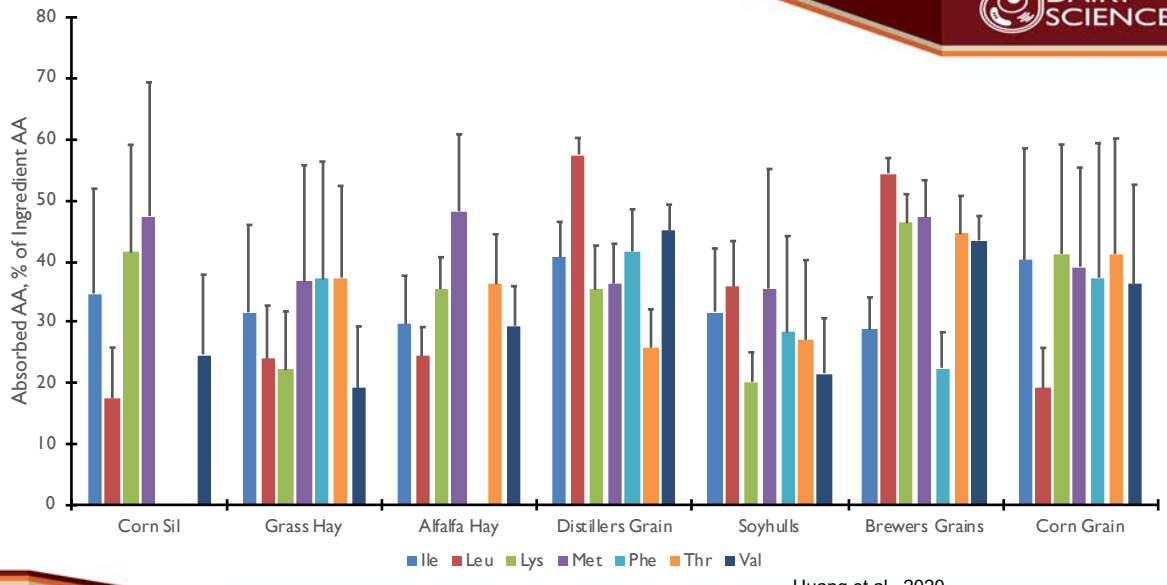
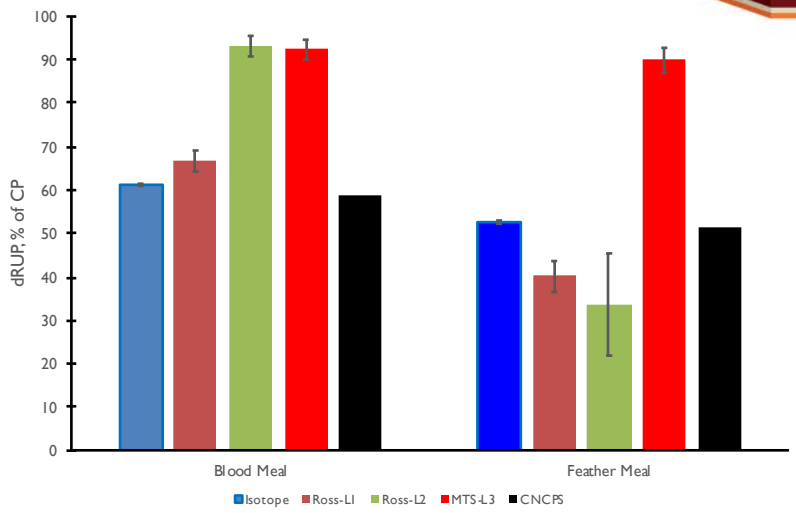


Huang et al., 2020

In Vitro Assessment of dRUP



Estes et al., unpublished

Summary and Questions

- Multiple ways to assess amino acid bioavailability
- Accuracy
  - In vitro: may be extremely biased
  - Pulse dose: underestimates with slow release
  - Milk protein response: might be nonlinear → bias
  - Jugular tracer infusion: underestimates by 3-10%
- Precision
  - intestinal disappearance: ↓
  - In vitro: ↑ w/in a lab but ↓ across labs
  - milk protein response: ↓ to ±
  - blood concentration increase: ±
  - pulse dose: ±
  - tracer dilution: ↑