When cows don’t perform like we think they should, the cows are not the ones who are wrong. What were we missing?

Carbohydrate fermentation drives microbial protein production. More carbohydrate fermentation = more organic acids and lower pH.

NFC & RDP and NDF Digestibility

Heldt et al., 1999

Heldt et al., 1999

NFC at 0.3% of BW

0.031% of BW as RDP

0.122% of BW as RDP

60 65.2 52.1 45.1 41.9

59.3 61.2 68.1 71.3 62.3

NDF digested %
Starch: Rates Subject To Change?

- Fermentation rates were increased at higher dietary starch levels.
- Change greater for rapid than slow rate.
- Greater protein degradability in HMSC affecting $k_d$?
- Basis for rapidly fermented grains being “touchy”?

Protein & Rumen pH

- NFC x RDP for Sugar v Citrus $P = 0.02$

Carbohydrate, Protein & pH

- Rapidly Avail. NSC
- High Degr. P
- RANSC:RDP

Protein Changes VFA?

- Sometimes, even when protein looks adequate, when we increase rumen degradable protein unexpected things happen…

DM Intake, lb/d

N & C effects, $P = 0.001$, $N_C = 0.05$

Total VFA, mmol/L

Hall et al., 2010

U.S. Dairy Forage Research Center

U.S. Dairy Forage Research Center
Protein, Intake, & Lactic Acid

- DM Intake, lb 3.5% FPCM, lb
- RDP, P=0.03
- Starch, P=0.78

- DGC+RDP
- DGC-RDP
- HMSC+RDP
- HMSC-RDP

Lactate, mmol
- RDP, P=0.01
- Starch, P=0.03

- 14% dry ground corn or HM corn. Silages: 7.5% grass, 32.5% corn, 15% alfalfa. 16.8% CP, 29% NDF, 19.6% starch

Changes in Digesta Amounts Before and After Feeding

- DM
- Lactate

Hall, 2013

Protein Changes Microbial Yield

- Increases in protein supply gave increased microbial YIELDS at each amount of carbohydrate in vitro.

NSC:DIP & Microbial Protein

- 54, 37, or 25% NFC in vitro, NSC:DIP ratio of 2 to 9.
- More degradable protein gave a greater yield of microbial protein per unit of carbohydrate.

Argyle and Baldwin, 1989

Hoover and Stokes, 1991
Protein supplementation changed yield of microbial protein from carbohydrate. How???

Carbohydrates that microbes utilize rapidly:
- glucose
- fructose
- sucrose
- lactose
- raffinose
- fructan
- starch

Glucose: Glycogen, mg

- Max 12-13% of glucose to glycogen
- N 0.03
- SED 0.04
- Lo v Hi 0.02
- T v U 0.04

Accumulated Glycogen C, mg

When microbes have more N they store less glycogen.
Counterbalancing

**More Glycogen**
- More energy to make glycogen
- Less energy for microbe growth
- Dampen pH drops
- Slows the fermentation
- Another SI “starch” source?

**Less Glycogen**
- Make more microbes (?)
- Make more lactate (less energy?)
- Greater ruminal digestion?
- Change passage (?)

WSC & Rumen Microbes

Hall, 2012

What Microbes Do With Energy

IF, microbes have all the nutrients they need:
- Stay Alive
- Make More Microbes

IF, something is lacking:
- Stay Alive
- Make Some Microbes
- Make Glycogen
- Waste Energy

Hall, 2012

Hall, unpub.
Rumen degradable protein affects:
- How rapidly carbohydrates are fermented in the rumen
- The efficiency of microbial growth
- Total microbe production

So What?
Feed efficiency starts in the rumen.
This fits in the big picture of what we need to do to keep the cow productive, more efficient, and healthy.

Summary
- Degradable protein affects carbohydrate use by rumen microbes, their efficiency, and potential nutrient supply.
- Don’t go and overfeed protein!!! Adjust timing for rapidly available protein relative to rapidly available carbohydrate?
- Rumen products need to be delivered to cow to be useful. How will kp affect net results?
- We have more to learn.