# Effect of source and frequency of metabolizable protein supplementation on milk production and nitrogen efficiency

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## Take-home message

Daily supplementation of rumen-protected His, Lys, and Met is used with a greater marginal efficiency than rumen-protected soybean and rapeseed meal, but every-other day supplementation of this AA mixture does not increase N efficiency over static supplementation.

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## Protein source and AA profile

- Metabolizable protein (MP) with an amino acid (AA) profile suited to mammary gland requirements for milk protein synthesis ↑ marginal efficiency of MP use (Haque et al., 2015; Nichols et al., 2019)
- Precision feeding motivates supplementing rumen-protected (RP) AA to balance AA profile of plant protein sources
- Studies of RP soybean meal or rapeseed meal supplemented with individual RP AA, but few comparisons of AA versus plant proteins (Martineau et al., 2013; Paula et al., 2020; Lage et al., 2021)

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## Protein oscillation

- Oscillating dietary crude protein (CP) content may improve N efficiency in growing ruminants (Archibeque et al., 2007; Doranalli et al., 2011)
  - ↑ N recycling and microbial protein synthesis, ↓ N excretion
- Few studies testing this concept in dairy cattle (Tebbe and Weiss, 2020; Rauch et al., 2021)
- Frequency of RP AA supplementation according to an oscillating pattern has not been investigated in lactating dairy cattle

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## Objective

- Investigate the effect of AA profile and supplementation frequency of metabolizable protein

1) Milk production and N efficiency

2) Mammary gland AA metabolism

3) Whole-body energy and N balance



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## Experimental design

- Randomized complete block design
- 28 Holstein-Friesian dairy cows (2.3 ± 0.9 lactations; 93 ± 27 DIM) blocked by DIM and parity

7-d basal diet adaptation | 13-d treatment adaptation | 4-d measurement



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## Experimental design

| Ingredient | % in ration DM |
|---|---|
| Corn silage | 41 |
| Grass silage | 32 |
| Concentrate | 27 |

- Basal total-mixed ration
  - 15.4% CP, 100% $NE_L$ requirement, 95% MP requirement (DM basis)
  - Fed a fixed amount according to mean ad libitum intake of block
- Milked and fed twice daily
  - Milk samples collected for composition analysis at each milking during measurement period

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## Treatments

1) **Control**: no supplement
2) **RP-AA**: 384-g mixture of RP His, Lys, and Met products **fed every day**
3) **Osc RP-AA**: 768-g mixture of RP His, Lys, and Met products **fed every-other day**

(2 and 3: Delivered AA in amounts relative to casein)

AJINOMOTO — **His = prototype**, **Lys = AjiPro-L**

ADISSEO A Bluestar Company — **Met = Smartamine M**

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# Treatments

1) **Control**: no supplement

2) **RP-AA**: 384-g mixture of RP His, Lys, and Met products **fed every day**

3) **Osc RP-AA**: 768-g mixture of RP His, Lys, and Met products **fed every-other day**

(2 and 3: Iso-AA profile)

4) **RP-SR**: 315-g mixture of RP soybean meal and rapeseed meal (50:50 mixture) **fed every day**

- All supplements delivered equivalent of 101 g MP/d (DM basis)
  → basal diet + supplement = 100% MP requirement

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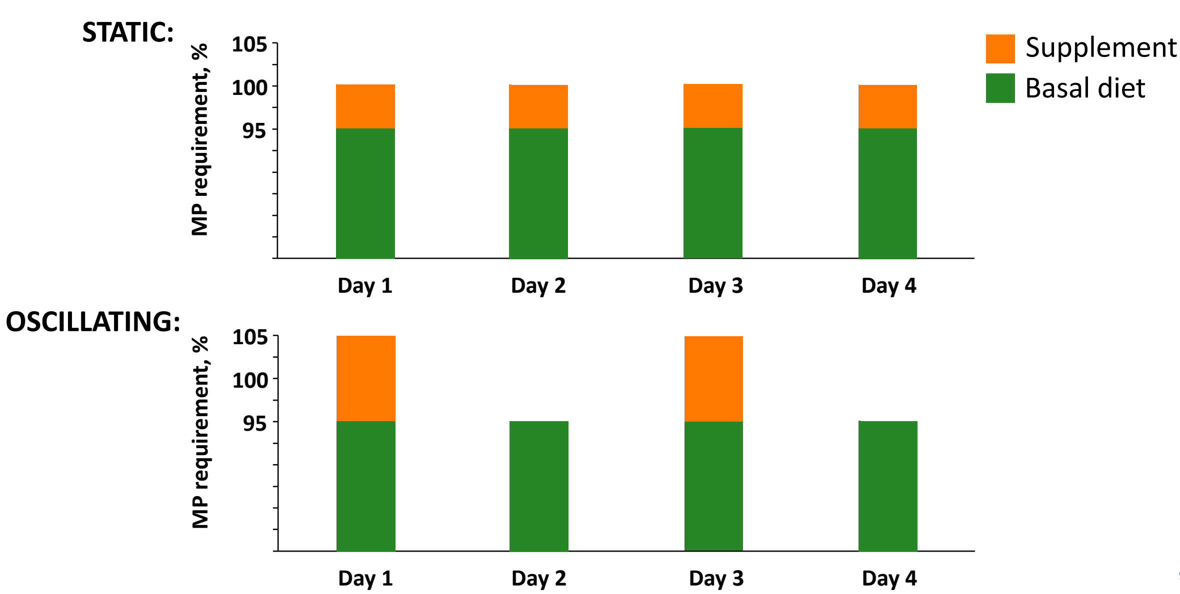
# Treatments

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## Experimental design

- Data averaged over the final 4 days of each period
  - Accounts for 2 oscillation cycles
- ANOVA using MIXED procedure (SAS version 9.4)
  - Fixed effect of treatment, random effect of block
  - Multiple comparisons with Tukey-Kramer test

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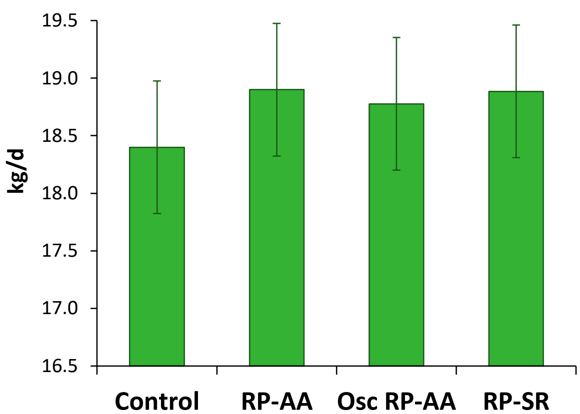
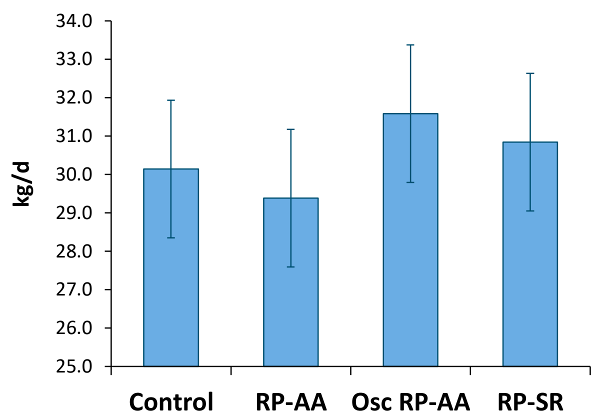
## Results

**Dry matter intake** *P* = 0.86




**Milk yield** *P* = 0.26

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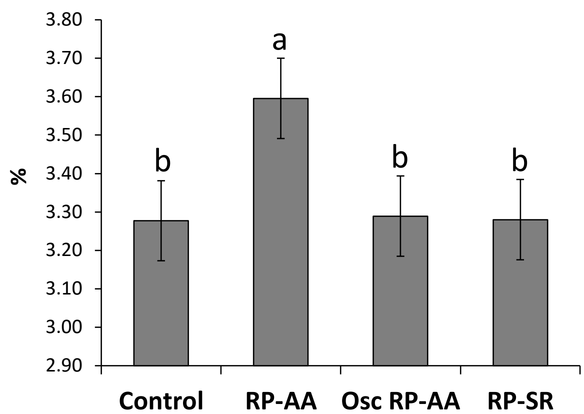
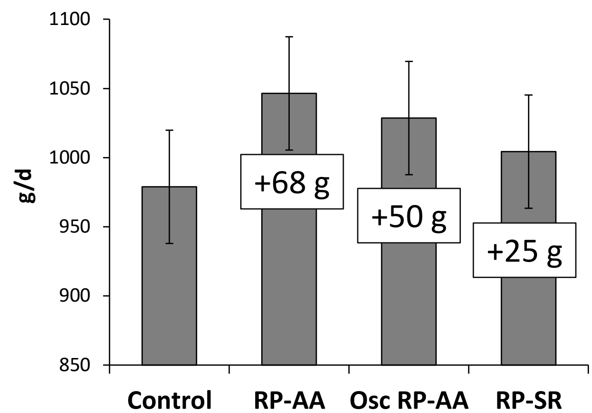
## Results

**Protein content** $P < 0.01$




**Protein yield** $P = 0.20$

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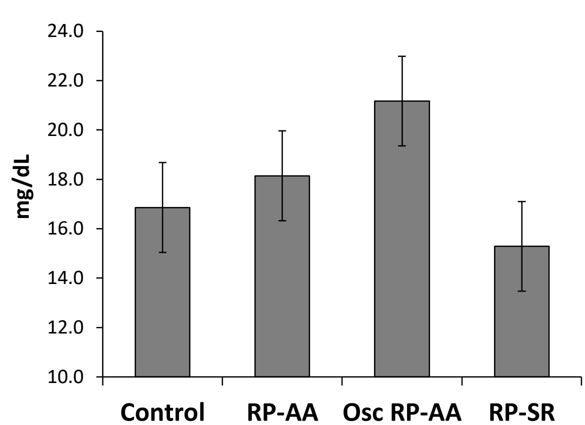
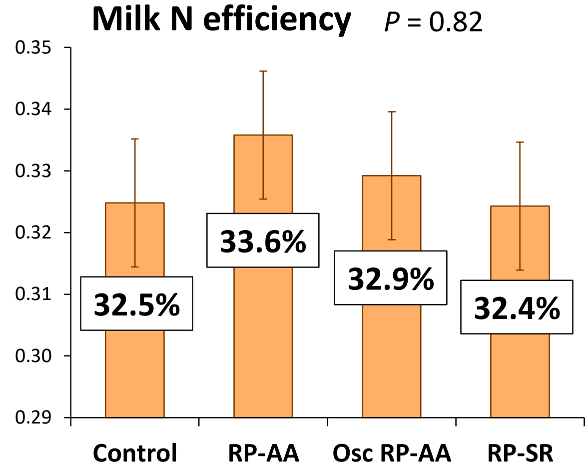
## Results

**Milk urea content** $P = 0.18$




**Milk N efficiency** $P = 0.82$

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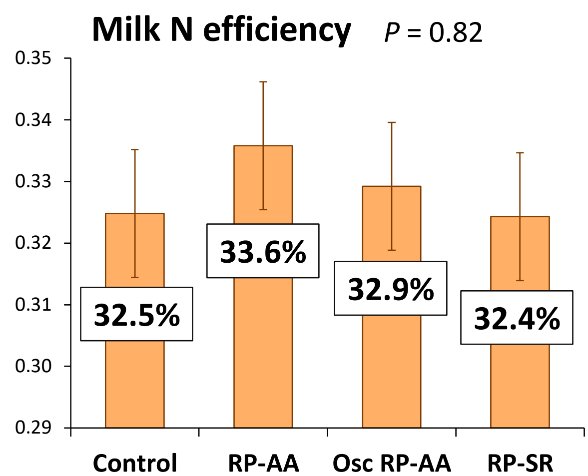
## Results

| | Marginal MP efficiency |
|---|---|
| **RP-AA** | 0.51 |
| **Osc RP-AA** | 0.43 |
| **RP-SR** | 0.14 |

- Milk protein produced per unit of extra MP supplemented

(4-d interval)

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## AA profile – RP-AA vs. RP-SR

- Milk protein content ↑ with RP-AA over all treatments
  - Agrees with previous reports supplementing similar AA products (Lee et al., 2012; Giallongo et al., 2016)
  - More than double milk protein yield ↑ with RP-AA vs. RP-SR
- MP from His, Met, and Lys products used more efficiently for milk protein compared with RP soybean/rapeseed meal mixture
  - Impact of EAA only vs. EAA + NEAA on whole-body N metabolism

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## Oscillation – RP-AA vs. Osc RP-AA

- Osc RP-AA did not improve milk protein yield or N efficiency above that observed with static RP-AA → ↓ milk protein content
- Numerically highest milk urea content with Osc RP-AA
  - Excess AA or imbalance with higher dose → agrees with lower MP efficiency compared with static RP-AA
- Recent work does not indicate improvement in N efficiency at greater CP content fluctuations
  - 11.9 and 16.2% for 24 h (Tebbe and Weiss, 2020)
  - 13.4 and 16.5% for 48 h (Rauch et al., 2021)

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## Conclusions

- RP His + Lys + Met can be used with a greater marginal efficiency to ↑ milk protein content and yield compared with RP soybean meal + rapeseed meal
  - ↑ transfer of dietary N into milk N
- No benefit of oscillating supply of RP AA on milk production or milk N efficiency

**Thank you for listening!**

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