Optimizing Amino Acid Metabolism for More Sustainable Dairy Production

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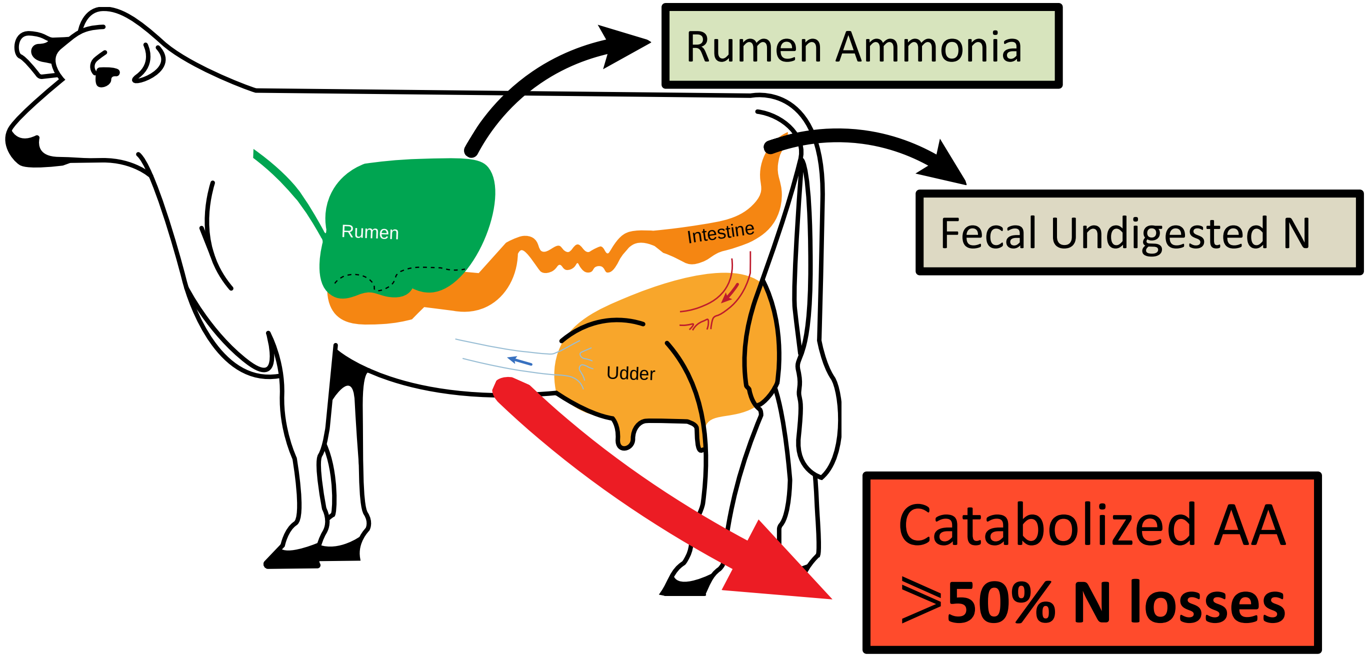
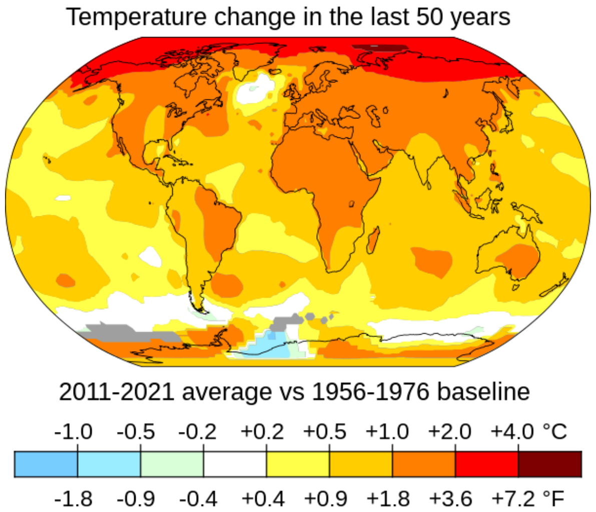
Importance of N efficiency



Global Warming

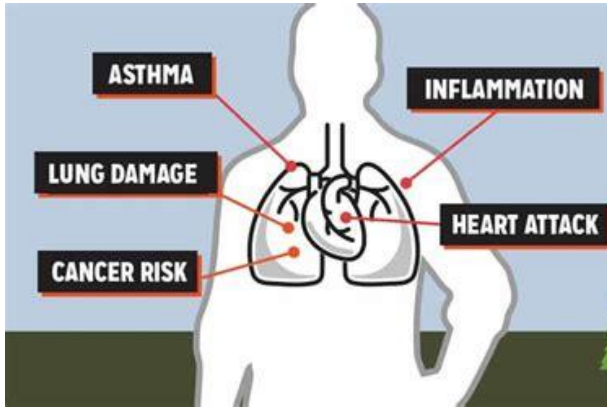


Wikipedia.org

Water pollution & Eutrophication

Lake Erie, NOAA, farmanddairy.com

Air pollution (PM2.5)



optimainstitute.com

The Dairy Industry needs to reduce N emissions

Arriola Apelo et al., 2014 (from Hristov et al., 2004 & Colmenero et al., 2006)		25% NUE
Spek et al., 2013		27% NUE
Brito & Silva, 2020	Jersey - Organic	21% NUE
	Jersey - Conventional	25% NUE
	Non-Jersey - Organic	27% NUE

istockphoto.com

How do we reduce N emissions?

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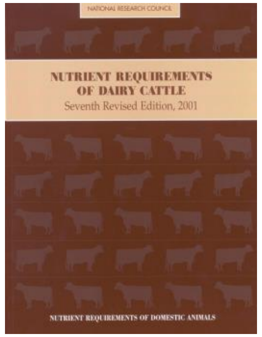
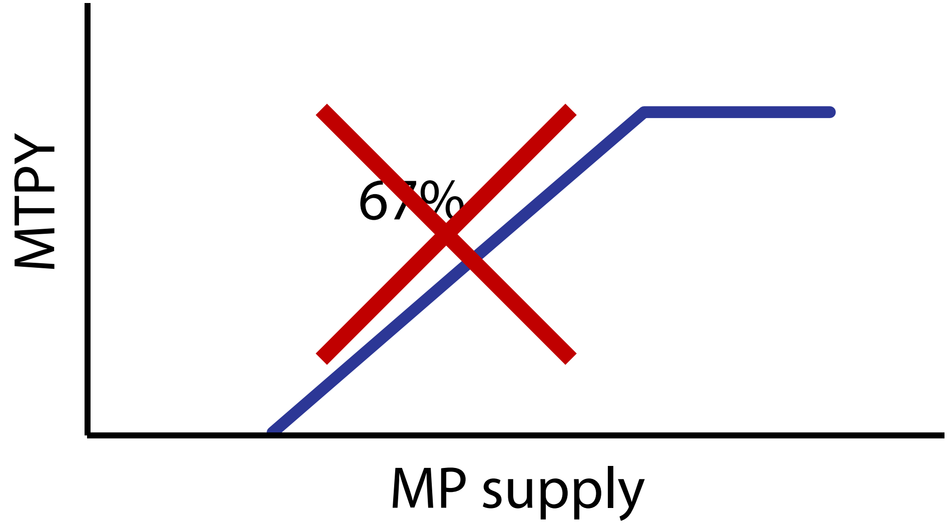
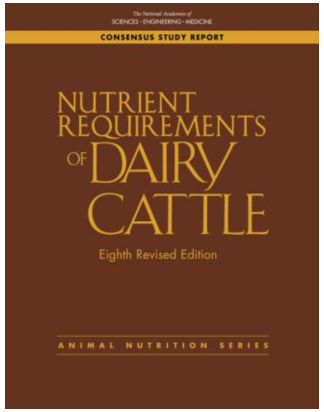
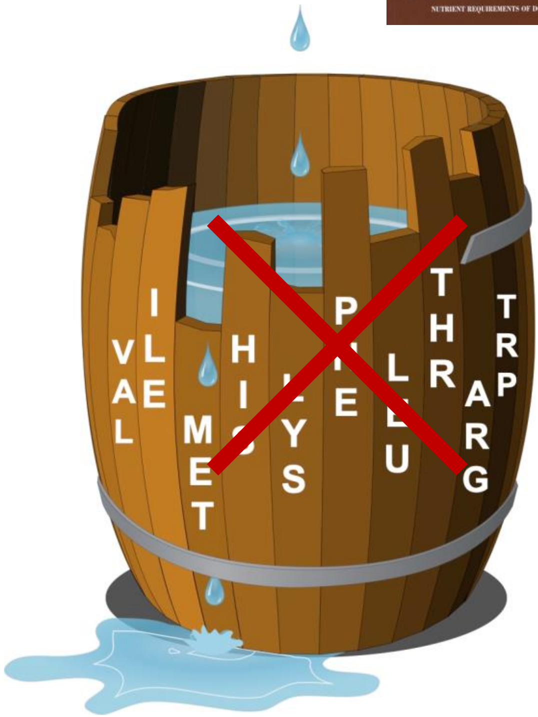
NRC 2001 Framework







NASEM 2021
Dairy 8



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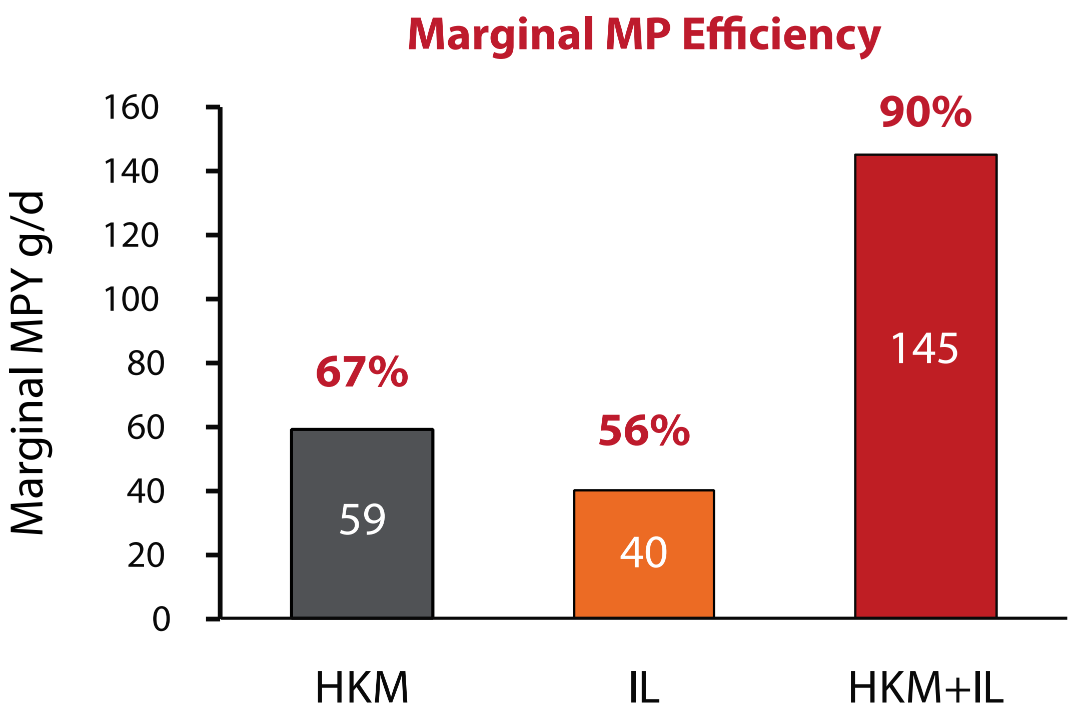
In vivo additive AA effects on MPY



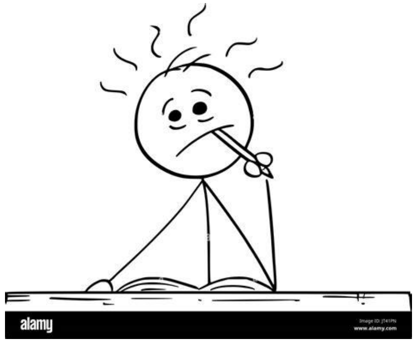
Dairy 8 eq 6-6

MPY (g/d) = Int
+ 1.68 x His
+ 0.885 x Ile
+ 0.466 x Leu
+ 1.15 Lys
+ 1.84 x Met
- 0.00215 ∑EAA2 . . .

n=8, 18 d periods, 4x4 LS
Daily jugular infusion:
- His (20g) + Lys (47.5 g) + Met (21g)
- Ile (22 g) + Leu (50 g)

Modified from Yoder et al,. 2020

What are we still missing?



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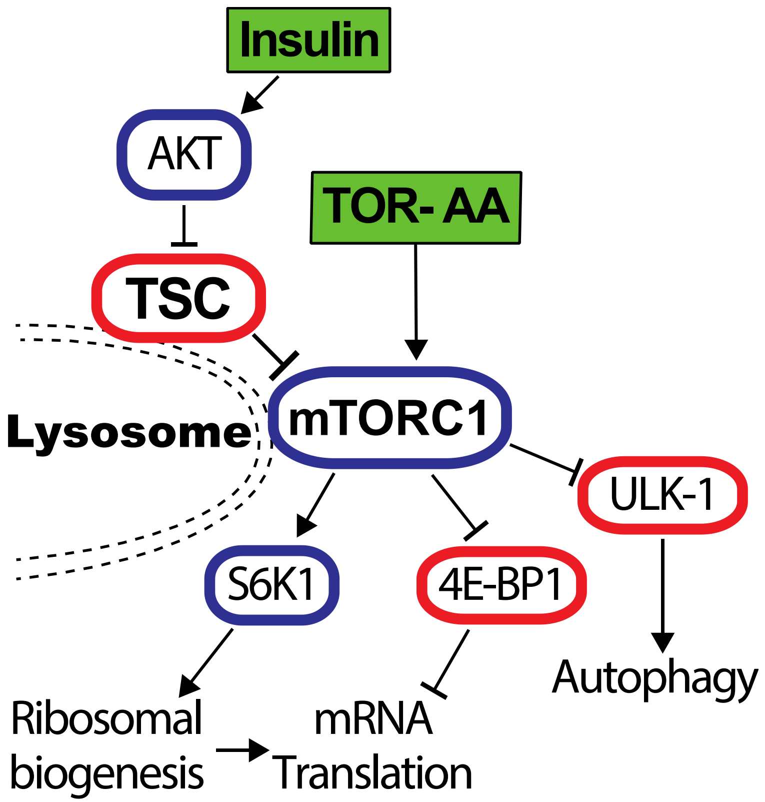
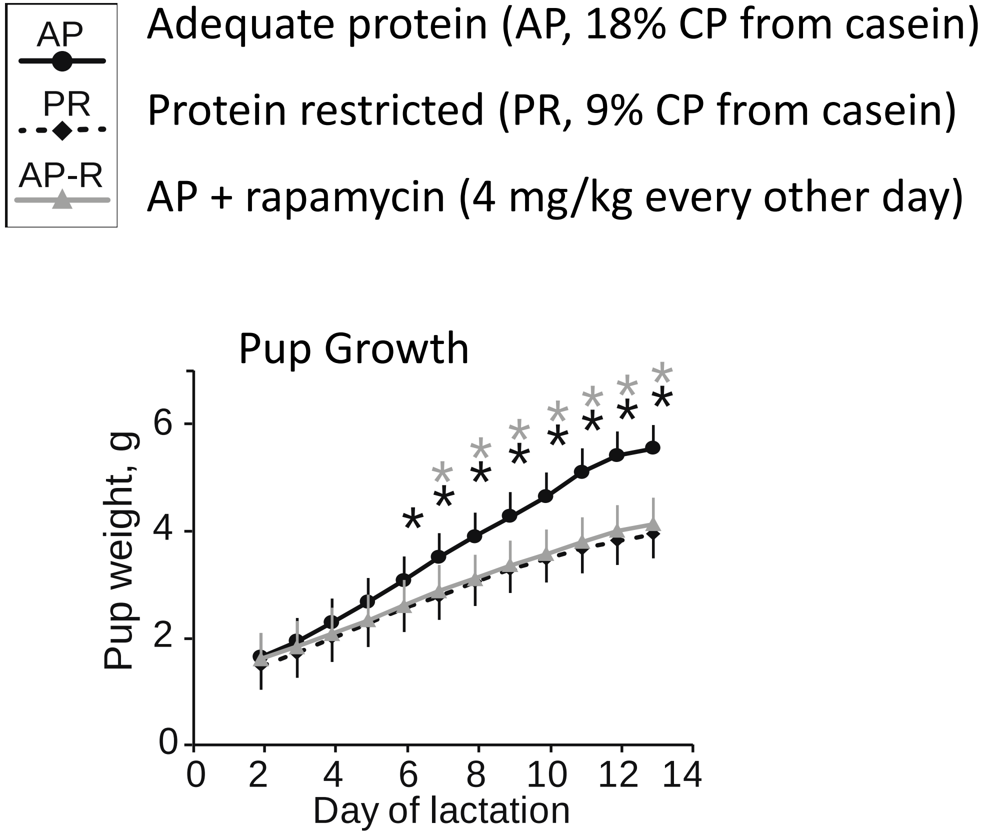
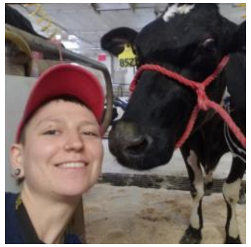
mTORC1 regulation of lactation







Pszczolkowski et al., 2020

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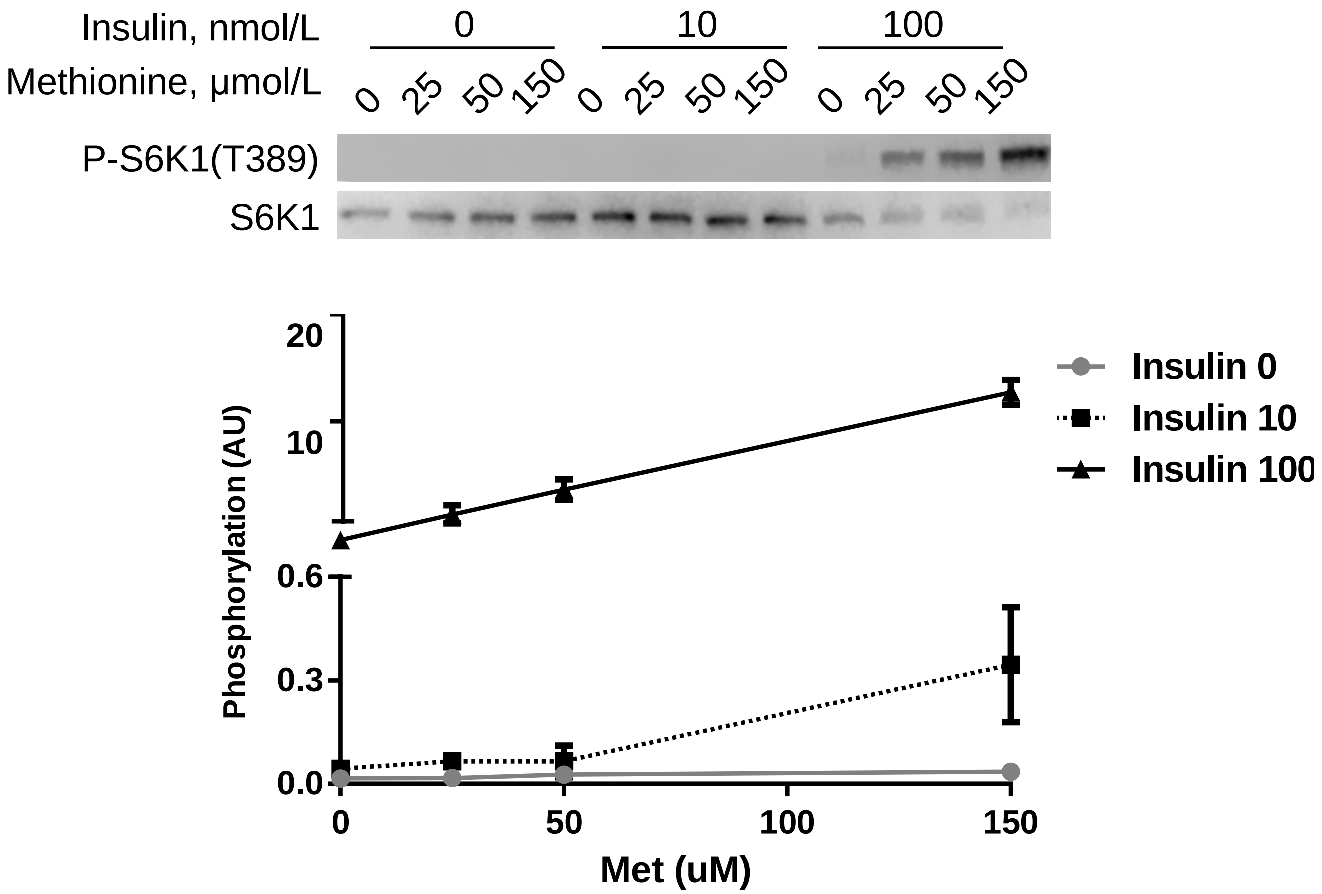
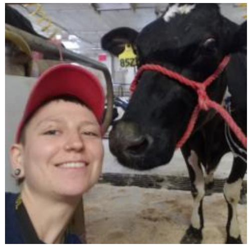
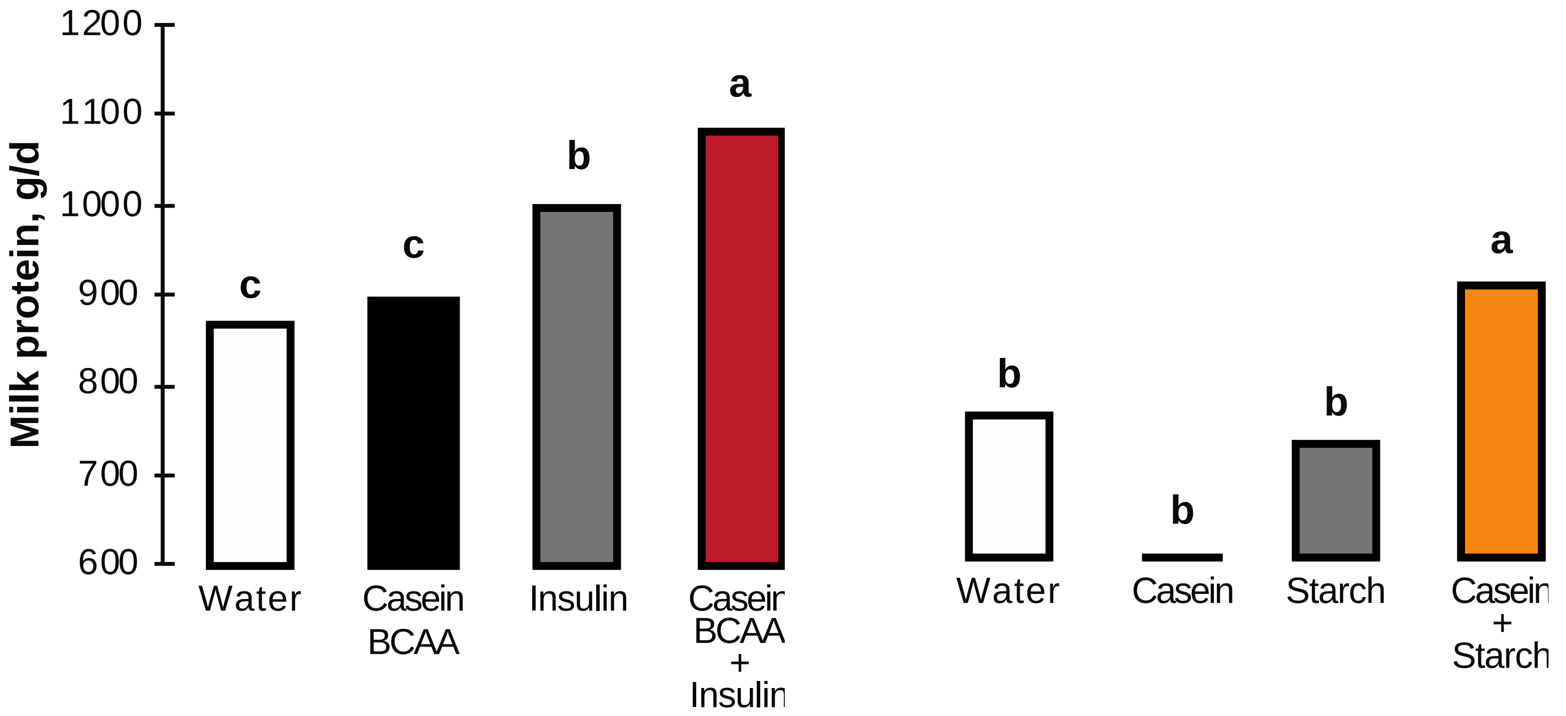
Insulin potentiates AA effects on mTORC1





Pszczolkowski, Zhang et al., 2020

Insulin potentiates AA effects on mTORC1



Mackle et al., 2000, JDS, 83:93

Rius et al., 2010, JDS, 93:3114

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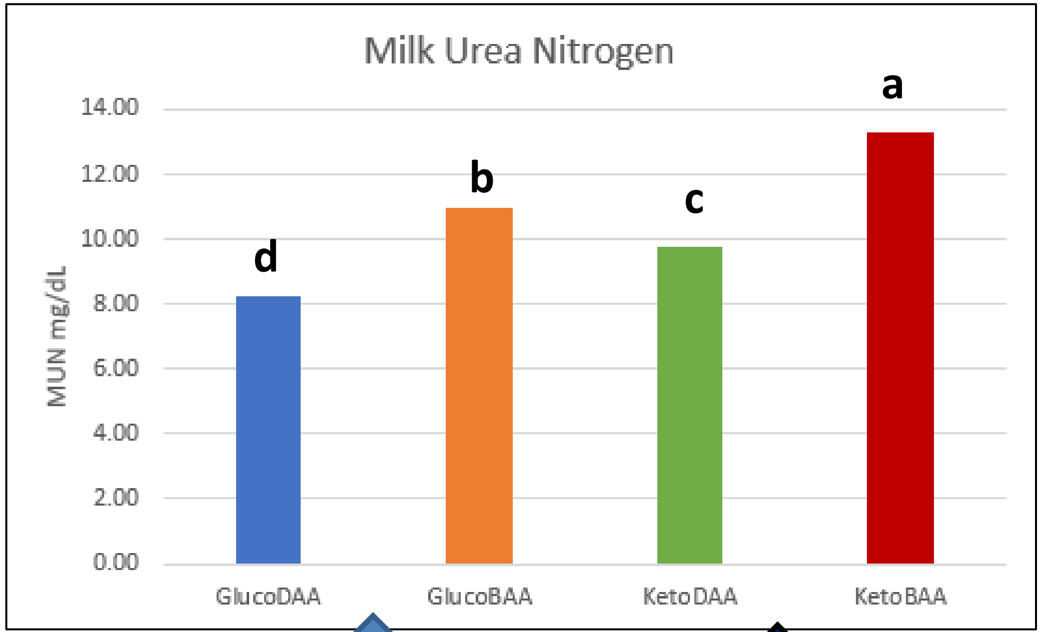
Energy source alter the effect of AA in NUE

	GE-DAA	GE-BAA	KE-DAA	KE-BAA	Energy Source *P* value	Amino acids *P* value	Interactions *P* value
Milk yield, kg	41.77	45.21	44.01	46.71	<.0001	<.0001	0.36
ECM, kg	42.34	45.88	46.23	49.29	<.0001	<.0001	0.64
Fat, kg	1.57	1.67	1.79	1.88	<.0001	<0.001	0.70
Protein, kg	1.19	1.36	1.23	1.38	0.03	<.0001	0.49
Lactose, kg	1.92	2.06	2.03	2.13	<.0001	<.0001	0.43
Fat, %	3.79	3.77	4.12	4.07	<.0001	0.50	0.73
Protein, %	2.86	3.04	2.84	2.98	0.10	<.0001	0.49
Lactose, %	4.59	4.55	4.62	4.57	0.44	0.17	0.78

Energy source alter the effect of AA in NUE

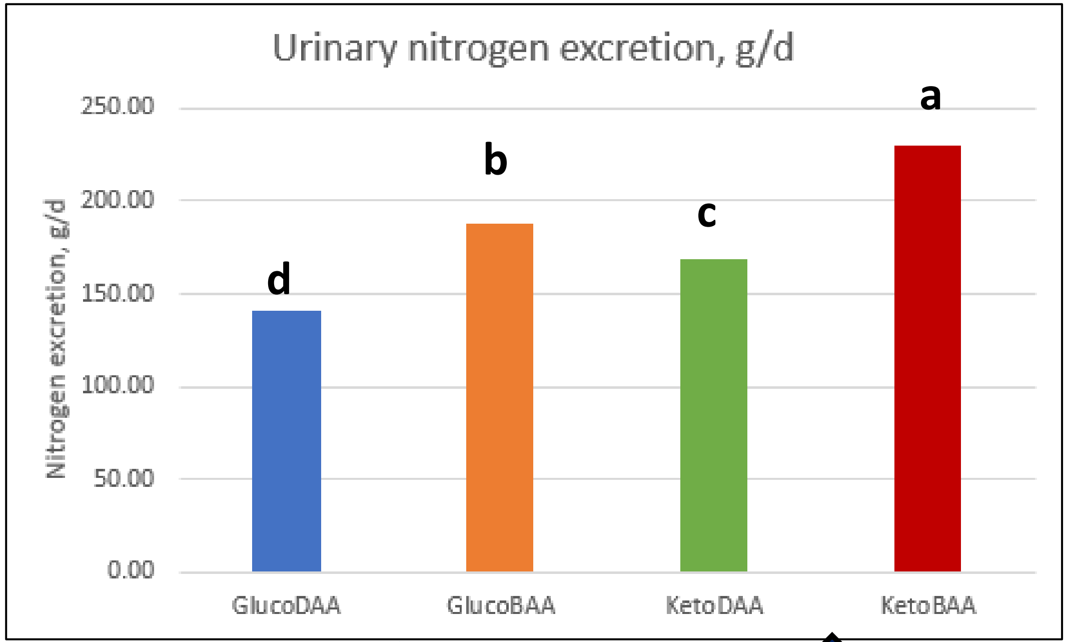
***P* value= 0.002**



32% **36%**

10.7 %

***P* value= 0.078**



33% **36%**

10.1 %

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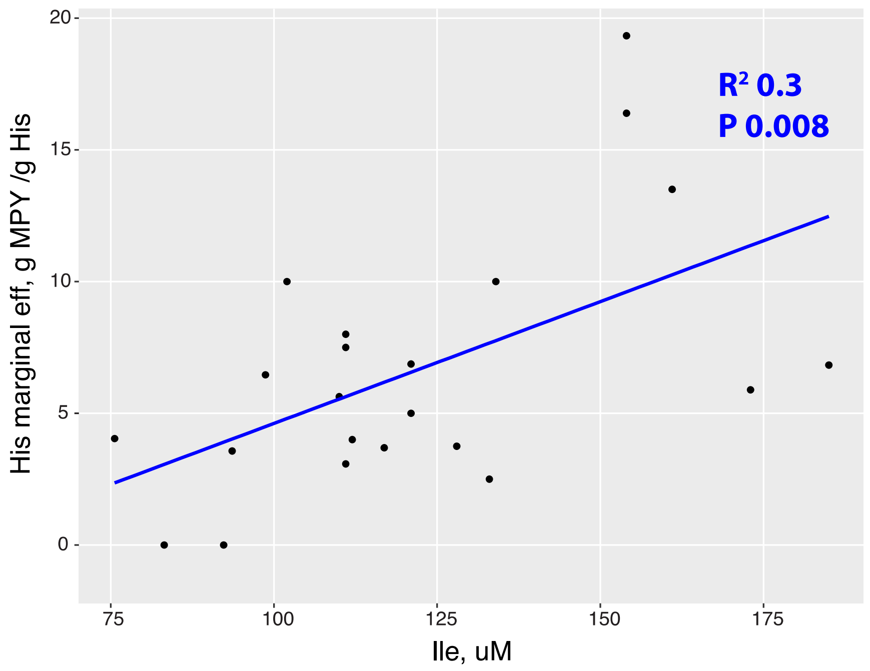
Metabolic flexibility of His efficiency

- 13 studies & 22 marginal efficiencies
- From 1999 - 2021
- Rumen protected, abomasal, duodenal, and jugular His supplementation
- Reported marginal digestible His supply
- Reported plasma AA concentration
- Calculated digestible His efficiency for MPY: **MPY / marginal dHis supply**



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Arriola Apelo et al., unpublished

Conclusions

- Dairy 8 has addressed major limitations of NRC 2001 (i.e. additive AA effects and diminishing responses)
- Implementation of current knowledge of AA metabolism and tools of ration formulation should reduce N emissions by the dairy industry

- mTORC1 is essential for lactation (at least in rodents)
- Glucogenic energy could potentiate the effect of TOR-AA
- Responses to non-TOR AA could be potentiated by mTORC1 activation
- **Digestible AA efficiencies (accurately predicted by Dairy 8) could be altered by mTORC1 activation status increasing N efficiency**

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