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Incorporation of butyric and caproic acid in milk replacer modulates postprandial metabolism in calves fed twice daily

Henry, A., **J. N. Wilms**, M. V. Sanz-Fernandez, T. Sugino, M. H. Ghaffari, H. Sauerwein, M. A. Steele, J. Martín-Tereso, and L. N. Leal

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UNIVERSITY of GUELPH

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C4:0 and C6:0 are missing from milk replacers !

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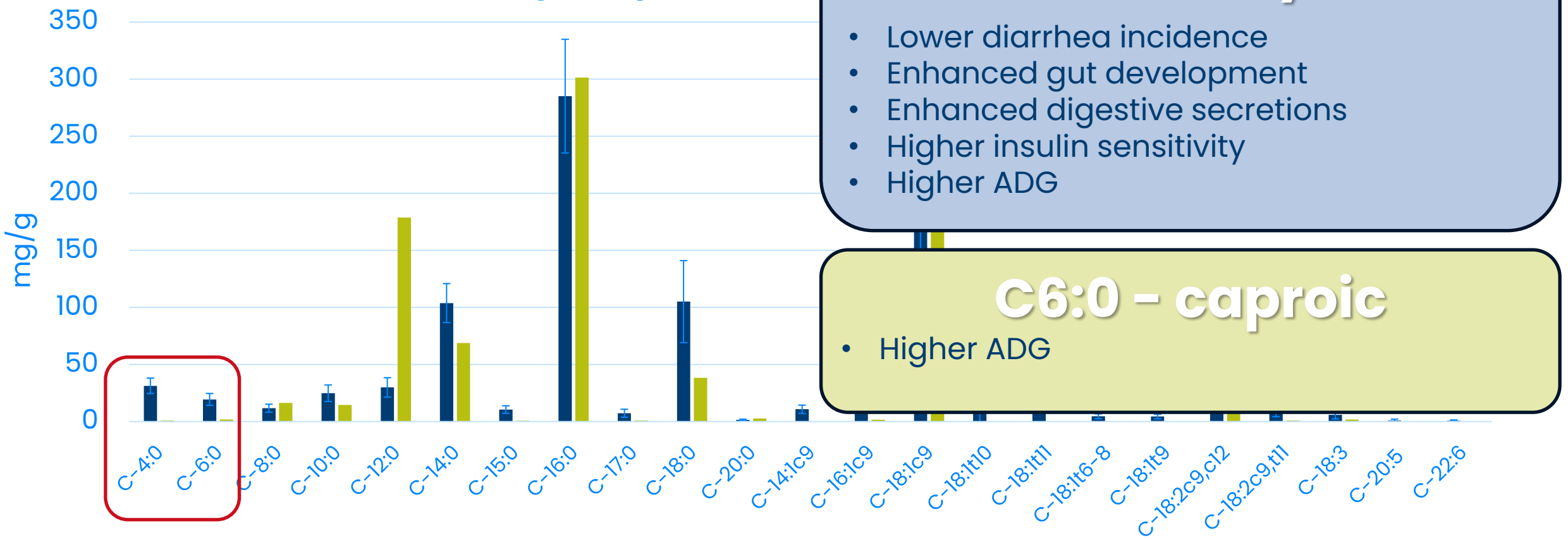

C4:0 - butyric

- Lower diarrhea incidence
- Enhanced gut development
- Enhanced digestive secretions
- Higher insulin sensitivity
- Higher ADG

C6:0 - caproic

- Higher ADG

Aurousseau et al., 1983, 1984; Moate et al., 2007; Guilloteau et al., 2010; Górka et al., 2011; Liu et al., 2021, 2022; Dell'Anno et al., 2023.

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How to supplement C4:0 (or C6:0) in milk replacers ?

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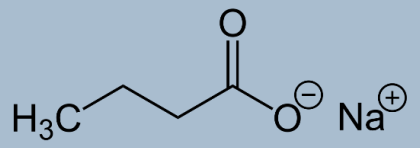
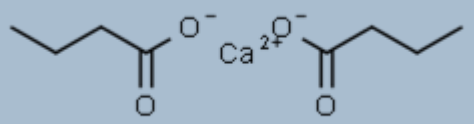
SALTS

Na-butyrate



Ca-butyrate



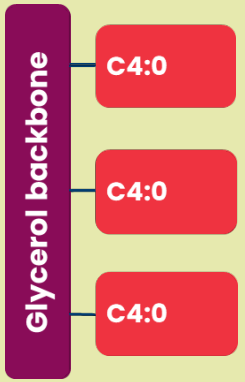
- Strong smell
- Differs from milk fat structure

ESTERS

Monobutyrin

Dibutyrin

Tributyrin



Hill et al., 2007; Guilloteau et al., 2009; Górka et al., 2014; Dell'Anno et al., 2023; Liu et al., 2022.

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Knowledge gap & Hypothesis

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KNOWLEDGE GAP

At high fat inclusion level, what is the impact of adding **tributyrin** and **tricaproin** in milk replacer (MR) at the same level as milk fat on abomasal emptying and postprandial metabolism?

HYPOTHESIS

Incorporation of tributyrin and tricarpoin in MR would affect hormones related to glucose metabolism and appetite regulation.

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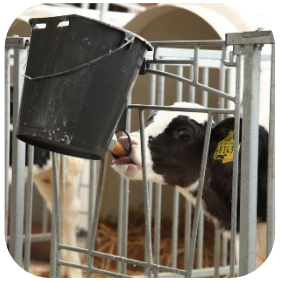
Experimental Animals & Feeding

ORIGIN	Collaborating dairy farms
BREED / SEX	100% Holstein male calves
AGE	24 to 72 h after birth
COLOSTRUM QUALITY	≥ 22% BRIX
COLOSTRUM QUANTITY	3.0-4.0 L within the first 3 h after birth, followed by 2× 2.0 L

FEEDING SCHEME (twice daily)



DAYS	MILK ALLOWANCE
1 – 5	6.0 L (3.0 L/meal)
6 – 9	7.0 L (3.5 L/meal)
10 – 42	8.0 L (4.0 L/meal)

135 g/L
13.5% solids

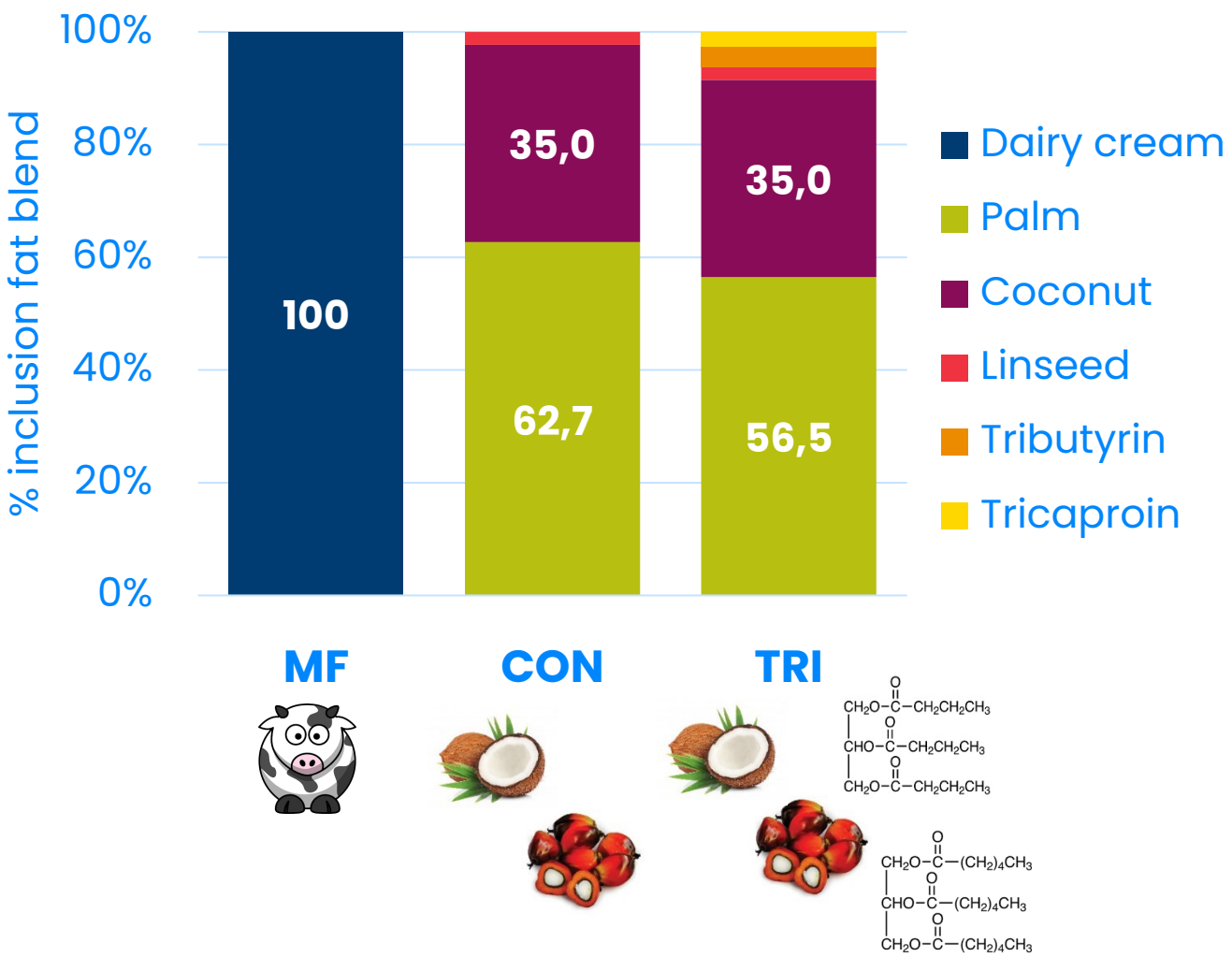
Chopped straw and water ad libitum

Week 1	Week 2	Week 3	Week 4	Week 5
		Postprandial sampling	**Total collection**	**Dissection**

Weekly BW and blood sampling

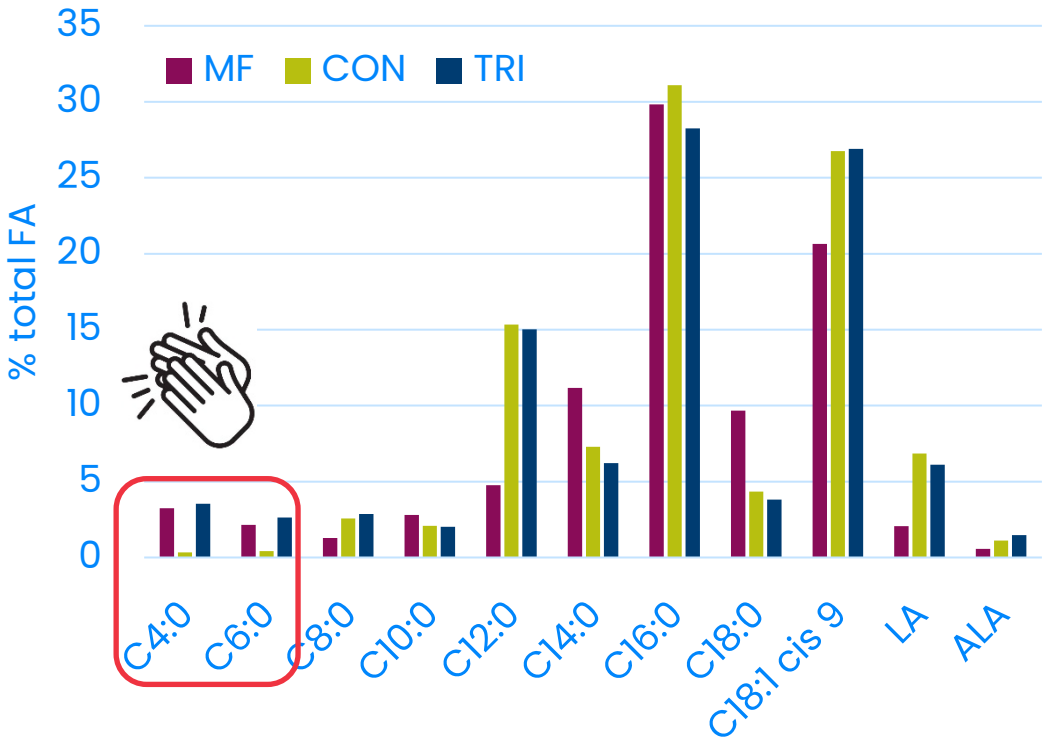
Calves blocked by arrival sequence and age at arrival.

Composition of the fat blends in milk replacers



15 calves per treatment

Fatty acid profile



Fat : 27 % DM
Protein : 24 % DM
Lactose : 36 % DM

LA = Linoleic acid
ALA = α-linolenic acid

No differences in total milk intake and growth

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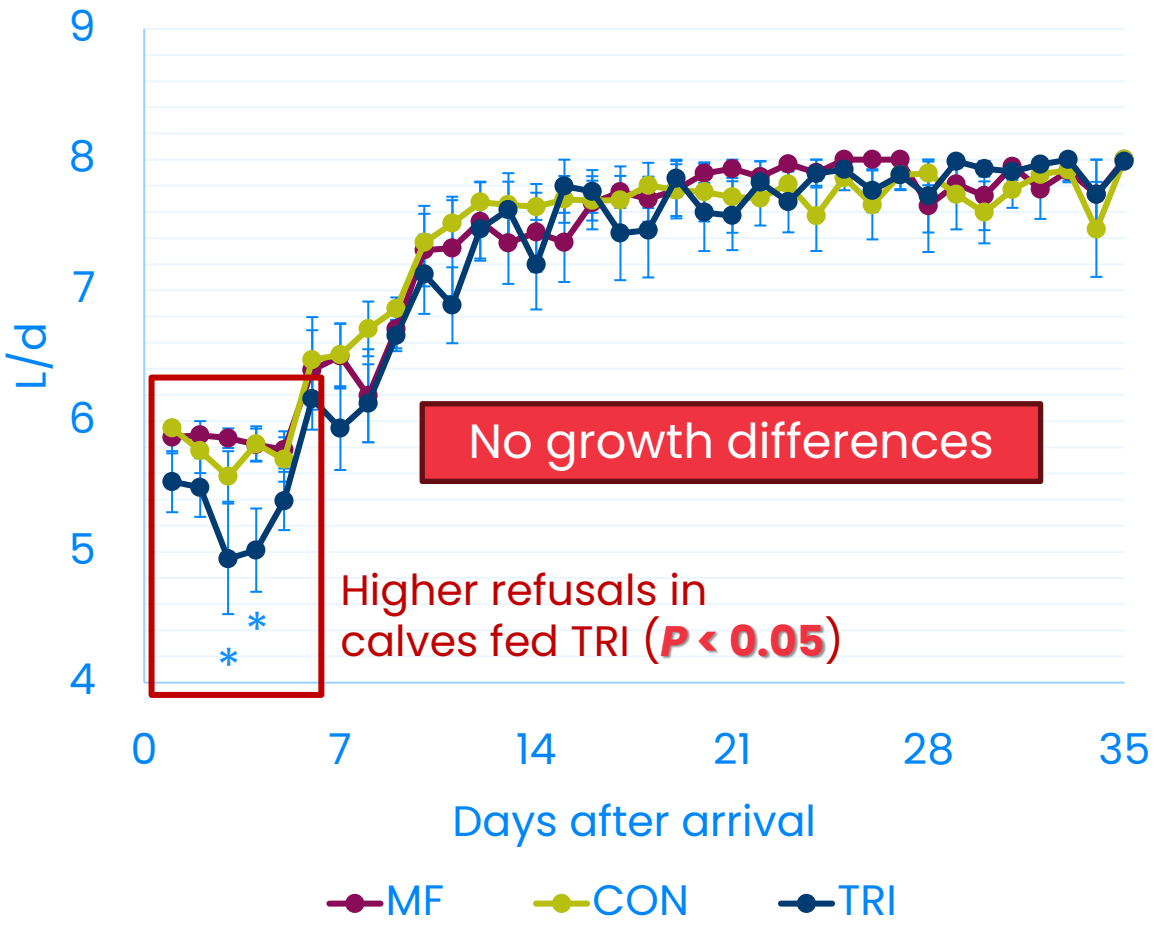

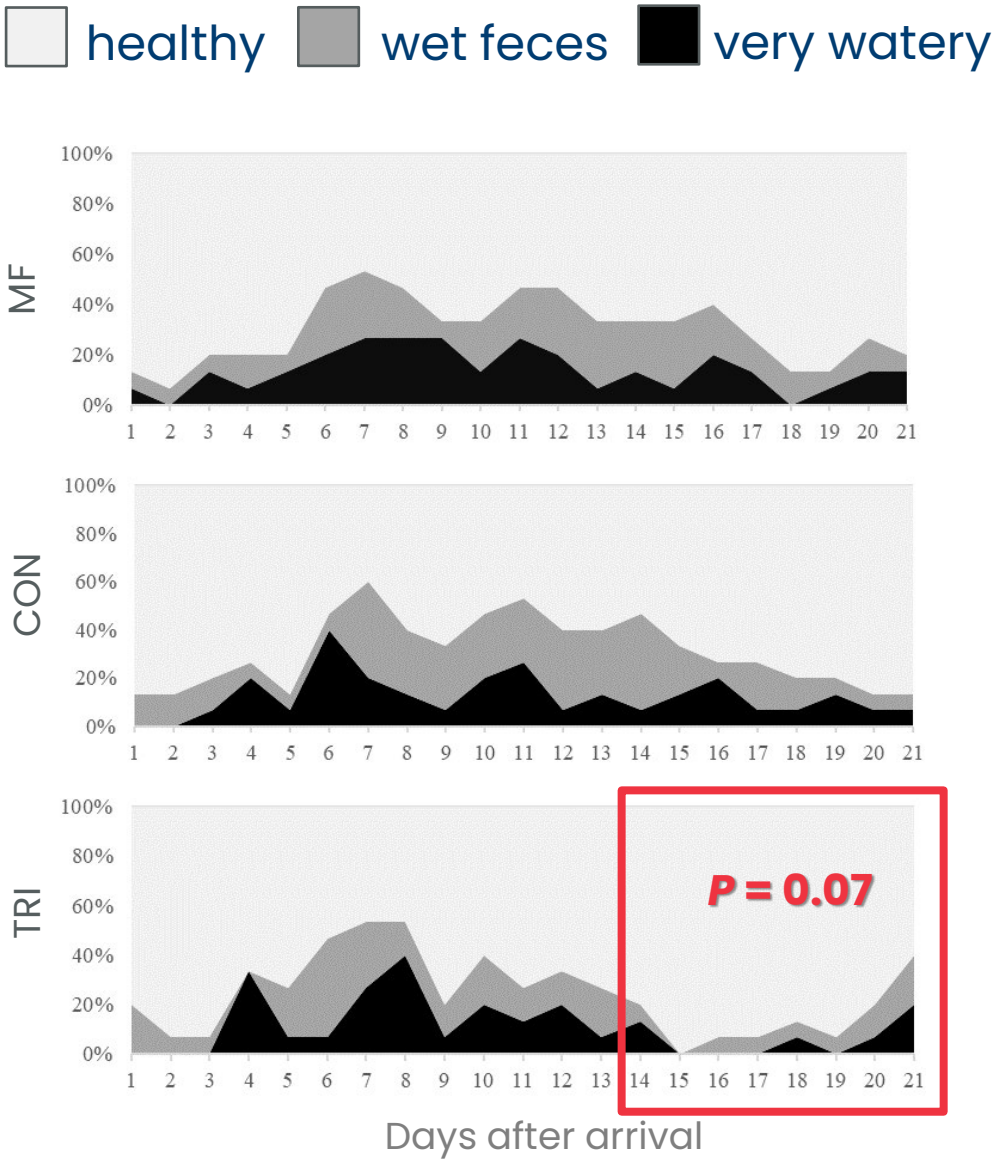

Slower abomasal emptying in calves fed TRI

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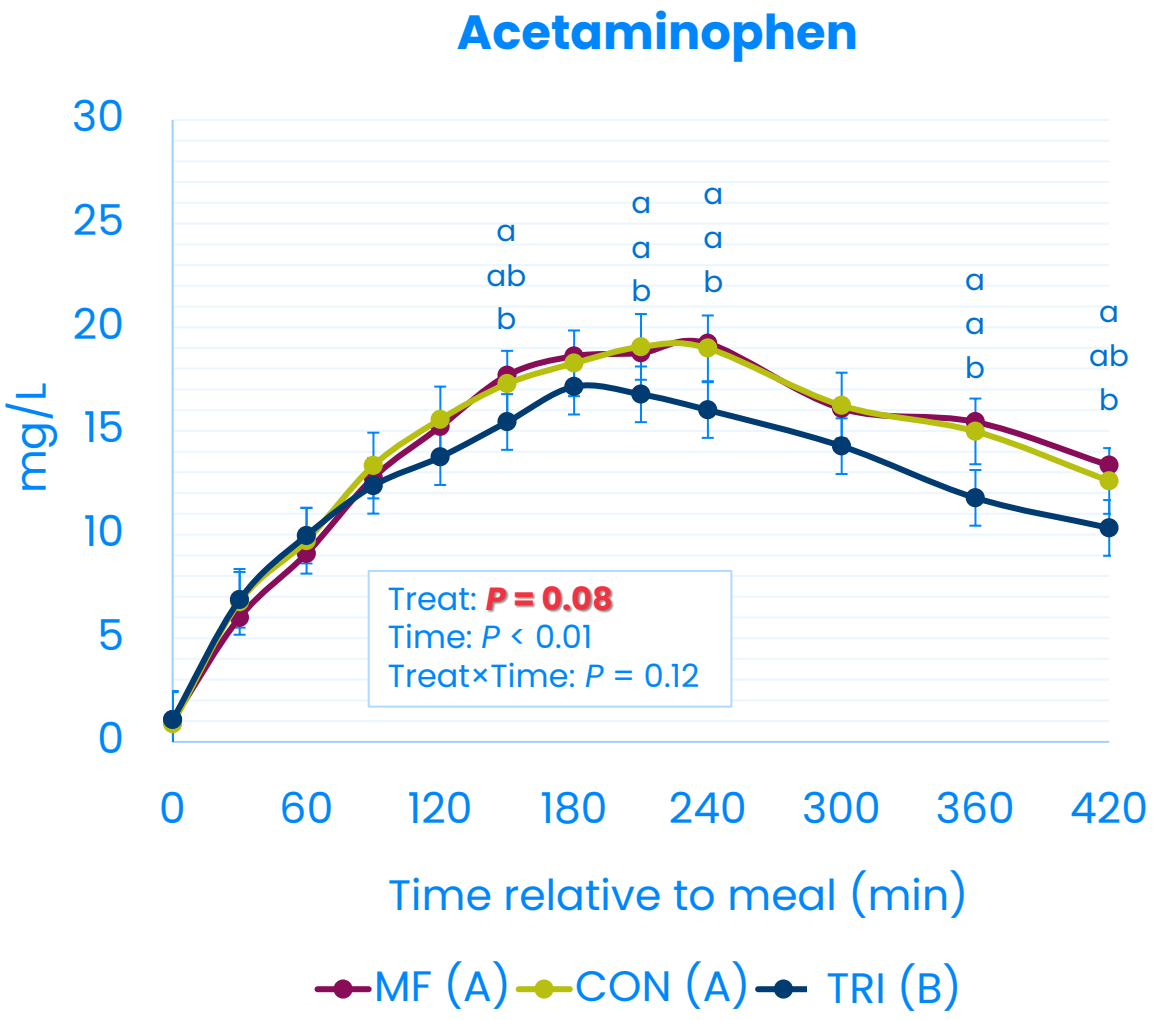

- **TRI vs. CON**: slower abomasal emptying likely due to reduced long-chain FA and / or increased SCFA / MCFA in TRI
- **TRI vs. MF**: slower abomasal emptying could be related to high C12:0 in TRI

	MF	CON	TRI	SEM	*p*-value
AUC (mg/L × 420 min)	40.6[a]	40.6[a]	35.7[b]	0.96	**0.05**
T_{max} (min)	188	190	166	14.9	0.46
C_{max} (mmol/L)	0.13	0.13	0.12	0.003	0.15

AUC = area under the curve

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Enhanced insulin sensitivity in calves fed TRI ?

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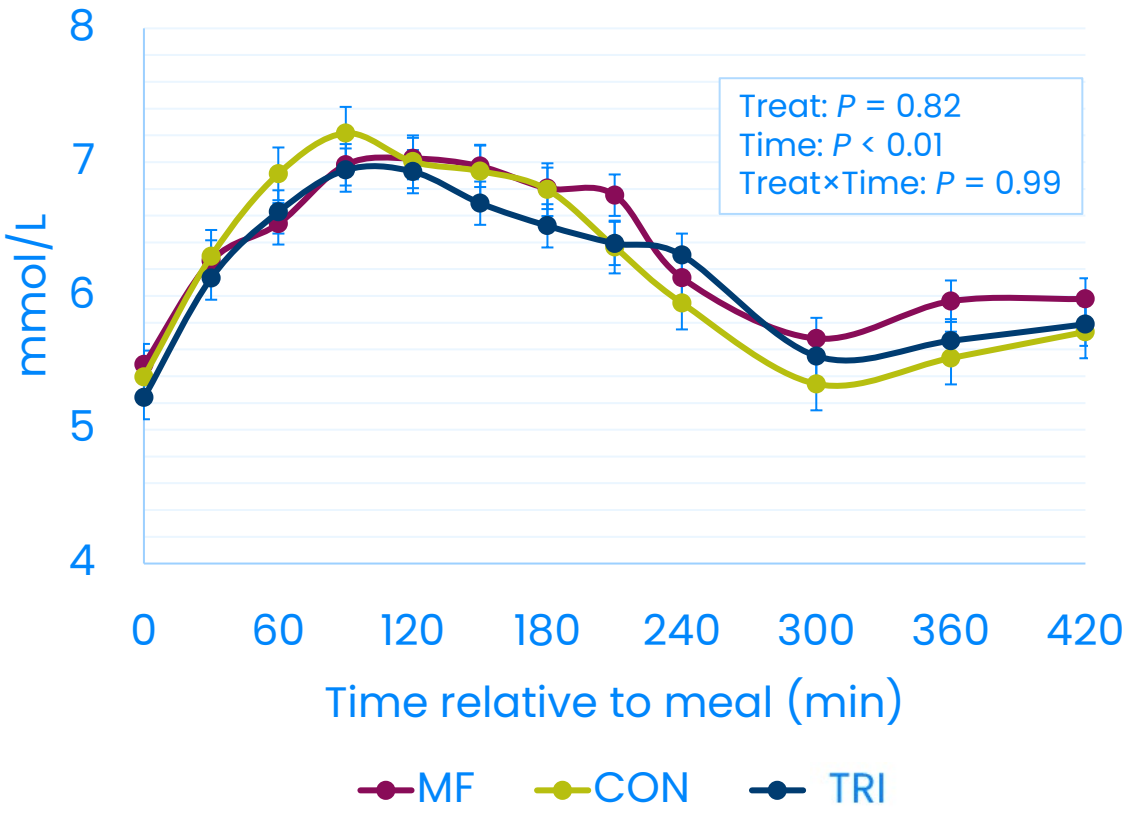
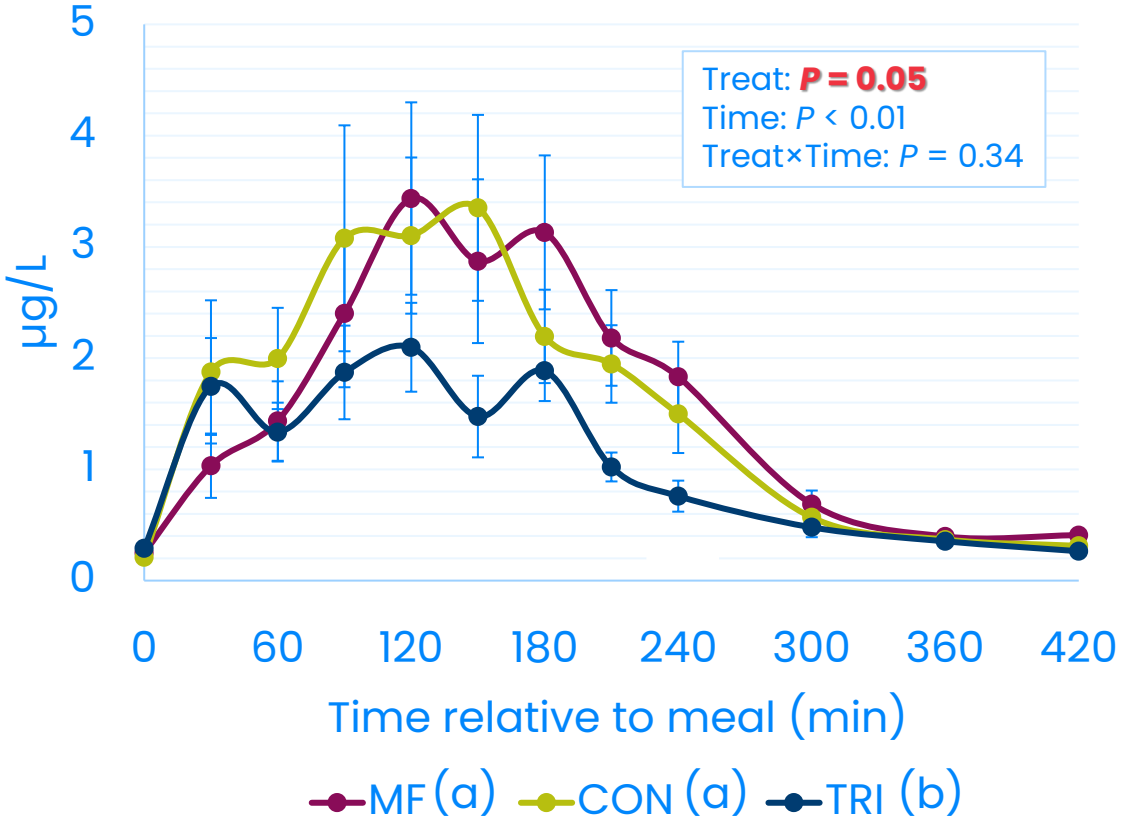
Glucose



	MF	CON	TRI	SEM	*p*-value
Basal (mmol/L)	5.49	5.39	5.24	0.15	0.51
C_{max} (mmol/L)	7.72	7.87	7.78	0.34	0.95
AUC (mmol/L × 420 min)	2656	2599	2596	75.5	0.82

AUC = area under the curve

Insulin



	MF	CON	TRI	SEM	*p*-value
Basal (mmol/L)	0.25	0.21	0.29	0.04	0.36
C_{max} (mmol/L)	4.87^{a}	4.85^{a}	3.24^{b}	0.44	**0.05**
AUC (µg/L × 420 min)	658^{a}	663^{a}	439^{b}	61.3	**0.05**

No differences in postprandial GLP-1 and GLP-2

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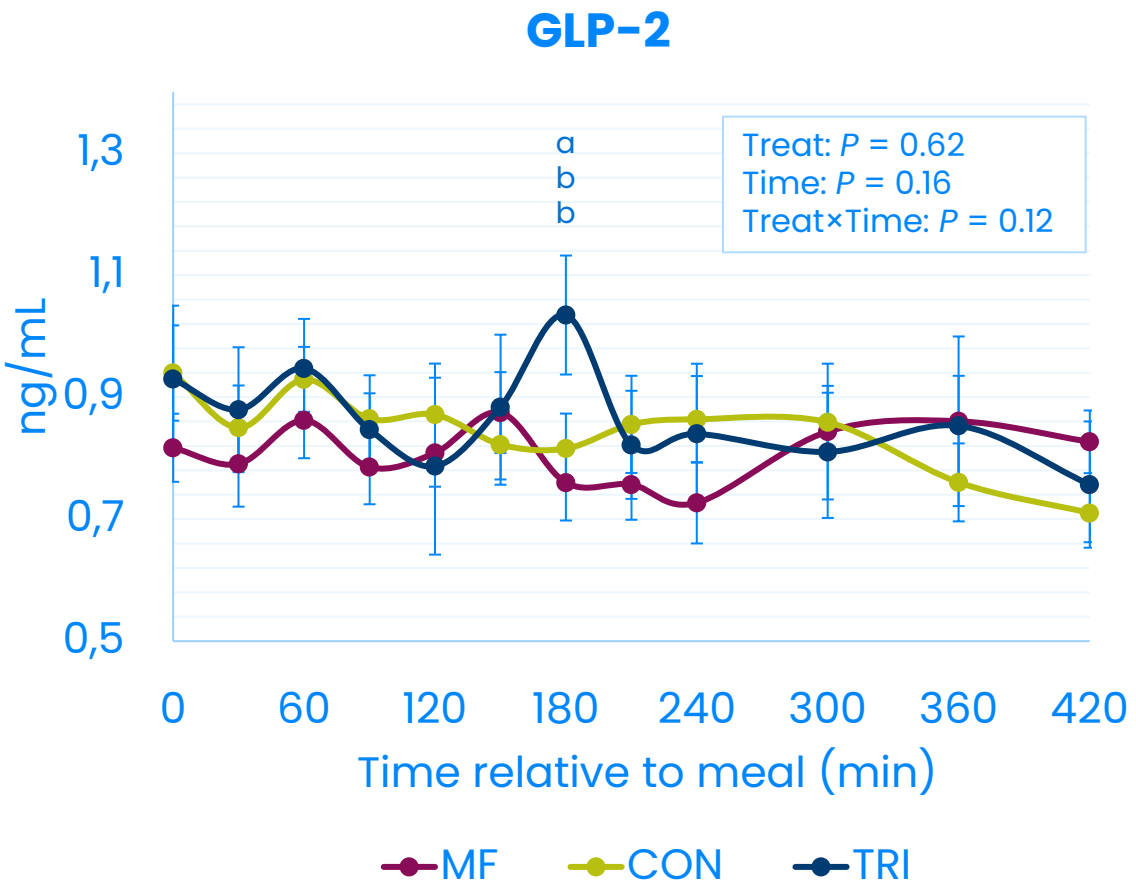

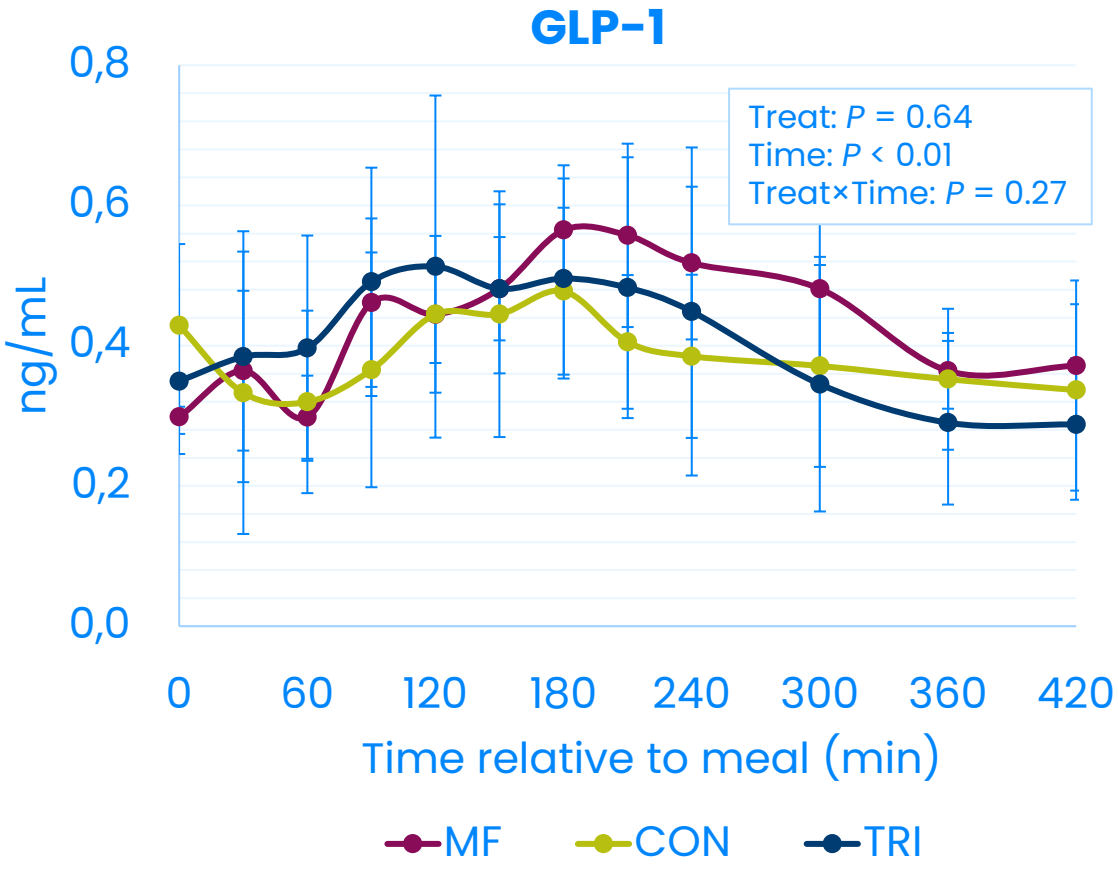

- **Gut-derived** neuropeptides involved in energy homeostasis and satiety (Lin et al., 2012; Yadav et al., 2013).

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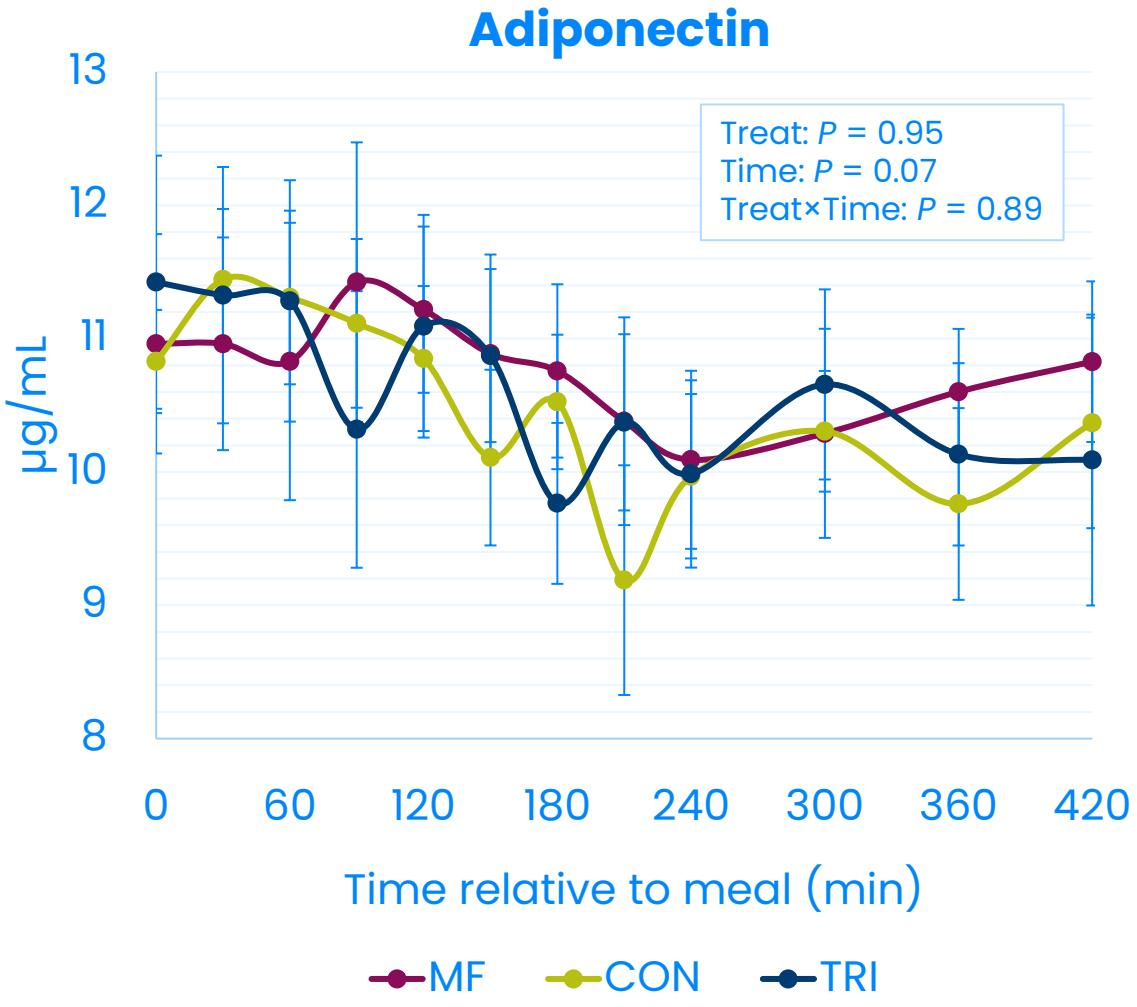
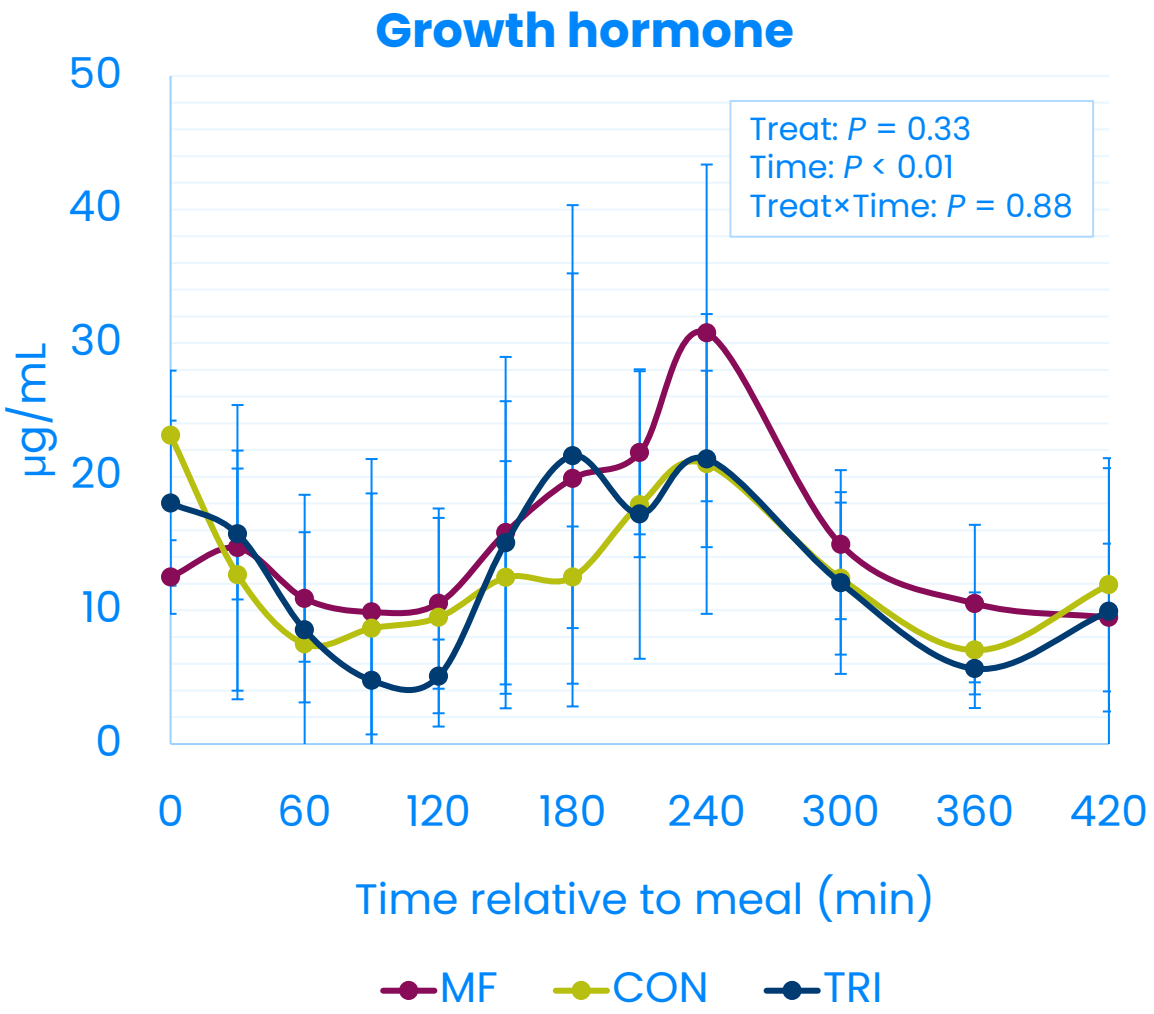
Postprandial adiponectin



- Adiponectin = **adipokine** that regulates lipid and glucose metabolism and insulin sensitivity (Kadowaki et al., 2006).

Postprandial growth hormone was not affected



- A pulsatile hormone
- Higher GH C_{max} for calves fed MF

	MF	CON	TRI	SEM	*p*-value
C_{max} (ng/mL)	121[a]	86.5[b]	82.2[b]	10.30	**0.02**
AUC (mM/L × 420 min × 10^3)*	11.65	9.23	8.80	0.126	0.13

AUC = area under the curve
*expressed as log SEM

Lower postprandial triglyceride with vegetable fats

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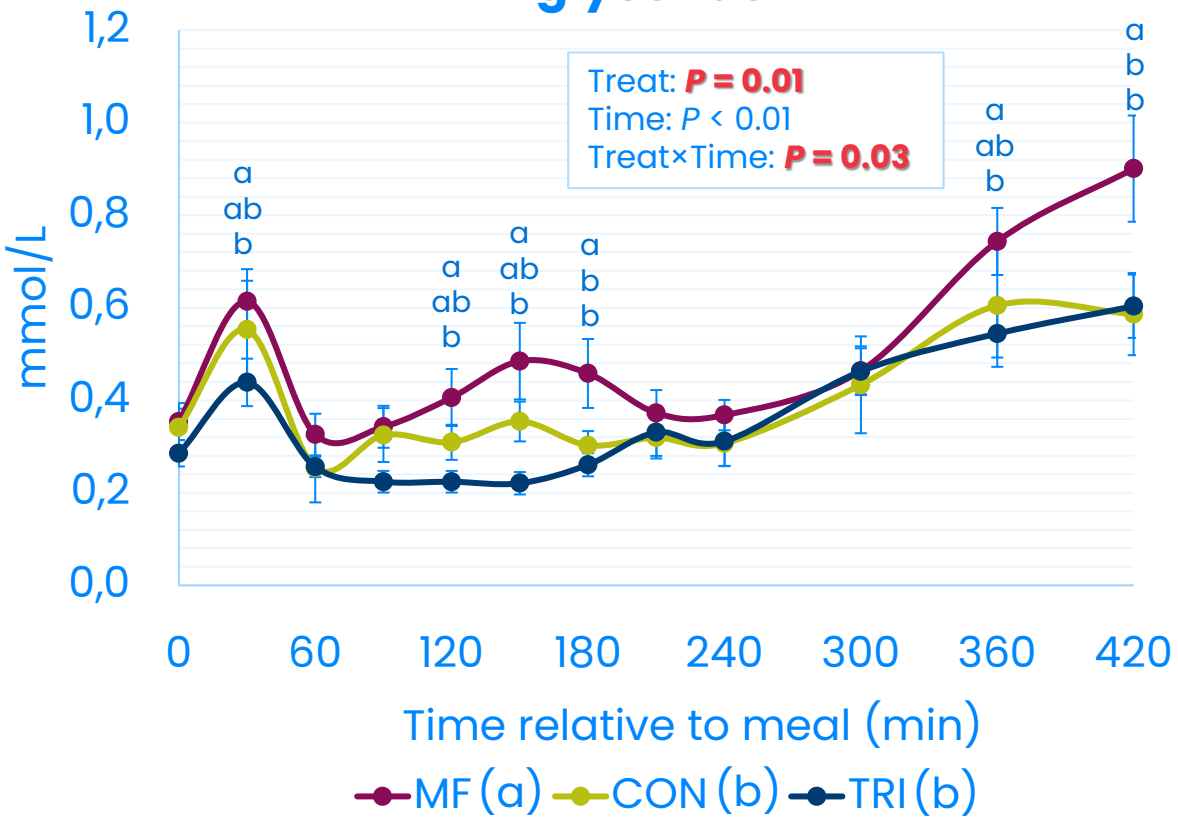
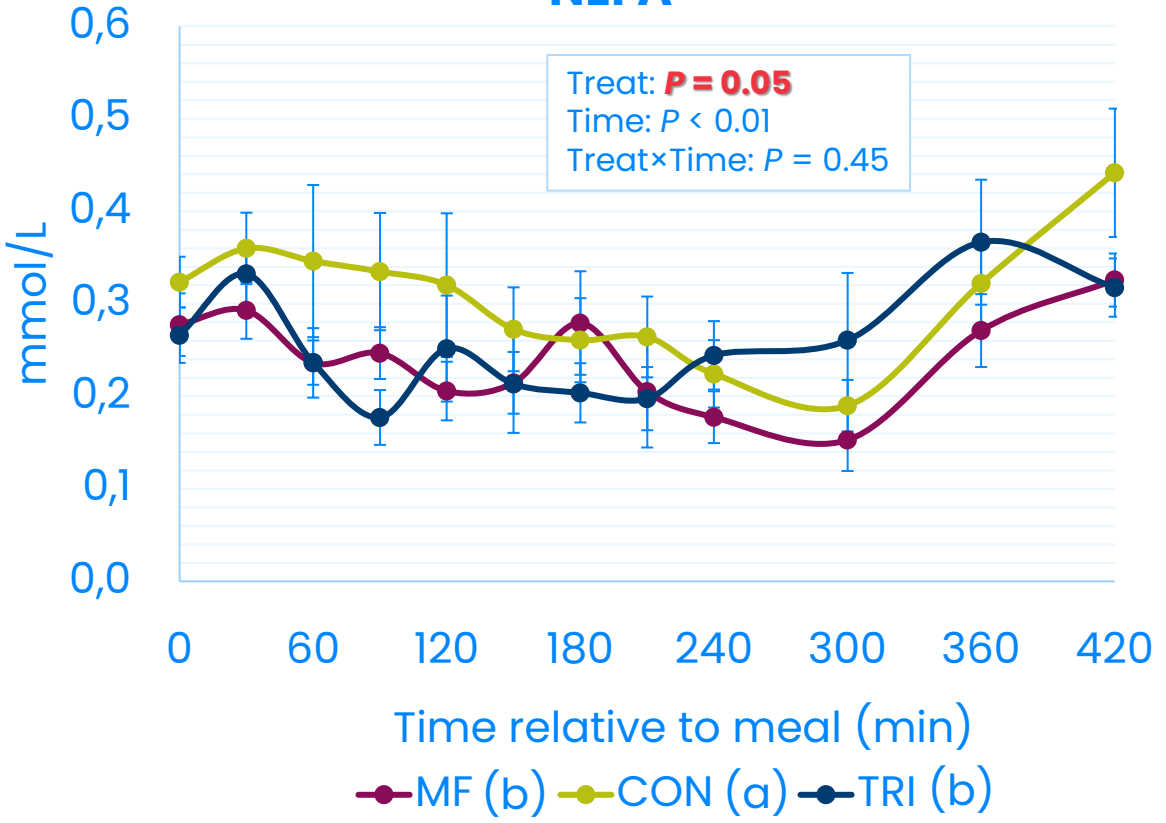
Triglyceride



NEFA



	MF	CON	TRI	SEM	*p*-value
Basal (mmol/L)	0.35	0.34	0.29	0.04	0.42
T_{max} (min)	328	302	336	36.9	0.79
C_{max} (mmol/L)	1.04^{a}	0.88^{b}	0.69^{b}	0.07	**< 0.01**

	MF	CON	TRI	SEM	*p*-value
Basal (mmol/L)	0.39	0.31	0.32	0.04	0.37
T_{max} (min)	158	140	220	36.1	0.27
C_{max} (mmol/L)	0.519	0.654	0.606	0.059	0.28

Conclusions

ABOMASAL EMPTYING	Slower abomasal emptying could be due to high medium chain fatty acid in TRI.
INSULIN-GLUCOSE METABOLISM	Indications of increased insulin sensitivity.
HORMONES	GLP-1, GLP-2, and adiponectin not affected by dietary treatments.
LIPIDS	Differences driven by vegetable vs. animal fats.

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Thank you

Email: juliette.wilms@trouwnutrition.com

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