



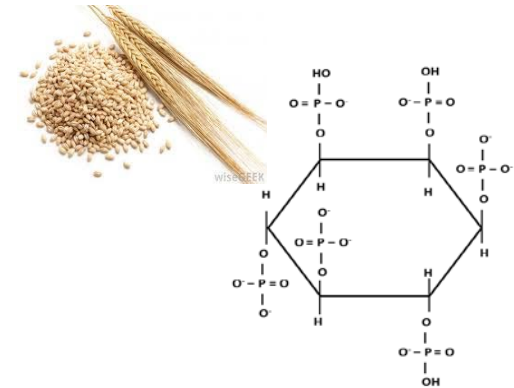
# Treatment with lactic acid of concentrates alleviates the lack of inorganic P in dairy cow diets

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# Background

- **Phosphorus (P):** key mineral for rumen microbes and the host ruminant
- in high-producing cows: P mainly provided via concentrates  
-> phytate-bound
- incomplete degradation of phytate via ruminal microbial phytase
- -> typically inorganic P supplemented

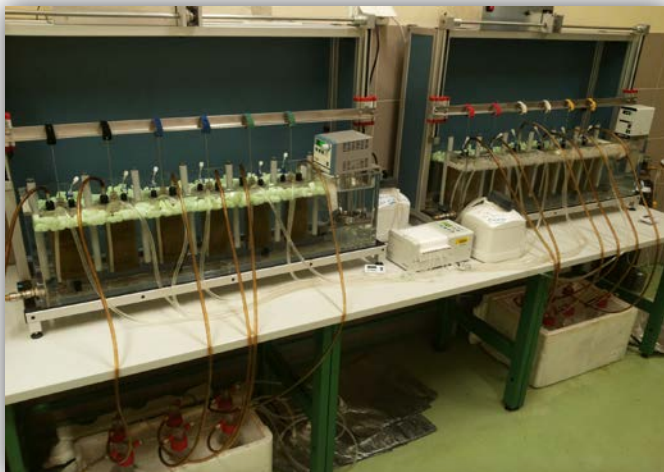


**P is the main polluting nutrients!**

**-> Methods to enhance the efficiency of the usage of phytate-P needed!**

# Background

## ■ Treatments of grains with organic acids (i.e., Lactic Acid)



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**Treatment of grain with organic acids at 2 different dietary phosphorus levels modulates ruminal microbial community structure and fermentation patterns in vitro**

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# Aim of the study

**Evaluation of the effects of feeding concentrates steeped in 5% Lactic Acid (LA) with or without inorganic P supplementation on:**

- Feed intake
- Milk production performance
- Metabolic health variables





# Material and Methods

- 16 cows (4 primiparous, 12 multiparous)
- 12 Simmental cows (initial BW: 798  $\pm$  24 kg)
- 4 Brown Swiss cows (initial BW: 642  $\pm$  22 kg)
  
- Included: from the day of parturition until d 37 postpartum
  
- loose-housing stable with straw bedding
- individual feeders with electronic weighing scales and computer-regulated access gates
  
- allocated to 1 of 3 different experimental groups



# Treatment of concentrate with LA

5% LA mixed  
soaked for 24 h  
Ratio solution:grain:1.2/1



Fed as TMR



Individual feeders

# Different TMRs for early lactating cows

Ingredient, % of DM	CON	LA (+P)	LA (-P)	Nutrient, % of DM unless stated	CON	LA (+P)	LA (-P)
Meadow hay	10.0	10.0	10.0	DM, % of FM	43.1	43.1	42.7
Grass silage	10.0	10.0	10.0	Ash	7.11	7.00	6.97
Corn silage	33.0	33.0	33.0	CP	18.5	18.9	19.5
Concentrate with inorganic P, without LA treatment <sup>1</sup>	47.0	-	-	NDF	34.8	33.5	31.6
Concentrate with inorganic P, with LA treatment <sup>2</sup>	-	47.0	-	ADF	22.3	21.7	19.7
Concentrate without inorganic P, with LA treatment <sup>3</sup>	-	-	47.0	NFC	37.5	38.4	39.8
				Ca, g/kg DM	9.63	9.66	9.58
				P, g/kg DM	4.53	4.64	4.13
				NE <sub>L</sub> , MJ/kg DM	7.06	7.23	7.17

<sup>1</sup> 55% barley, 25% soybean meal, 9% rapeseed meal, 4% wheat bran, 3% dried beet pulp, 0.45% limestone, 0.25% salt, **0.8% monocalciumphosphate**, 0.5% urea, and **2% mineral premix containing 4% P**.

<sup>2</sup> comprised of the same ingredients as the CON-concentrate but was **soaked in 5% LA for 24 h prior to feeding**.

<sup>3</sup> contained: 56.6% barley, 25% soybean meal, 9% rapeseed meal, 4% wheat bran, 2% dried beet pulp, 0.60% limestone, 0.25% salt, 0.5% urea and **2% mineral premix without P** and was **soaked in 5% LA for 24 h prior to feeding**.

# Data Collection and Analysis

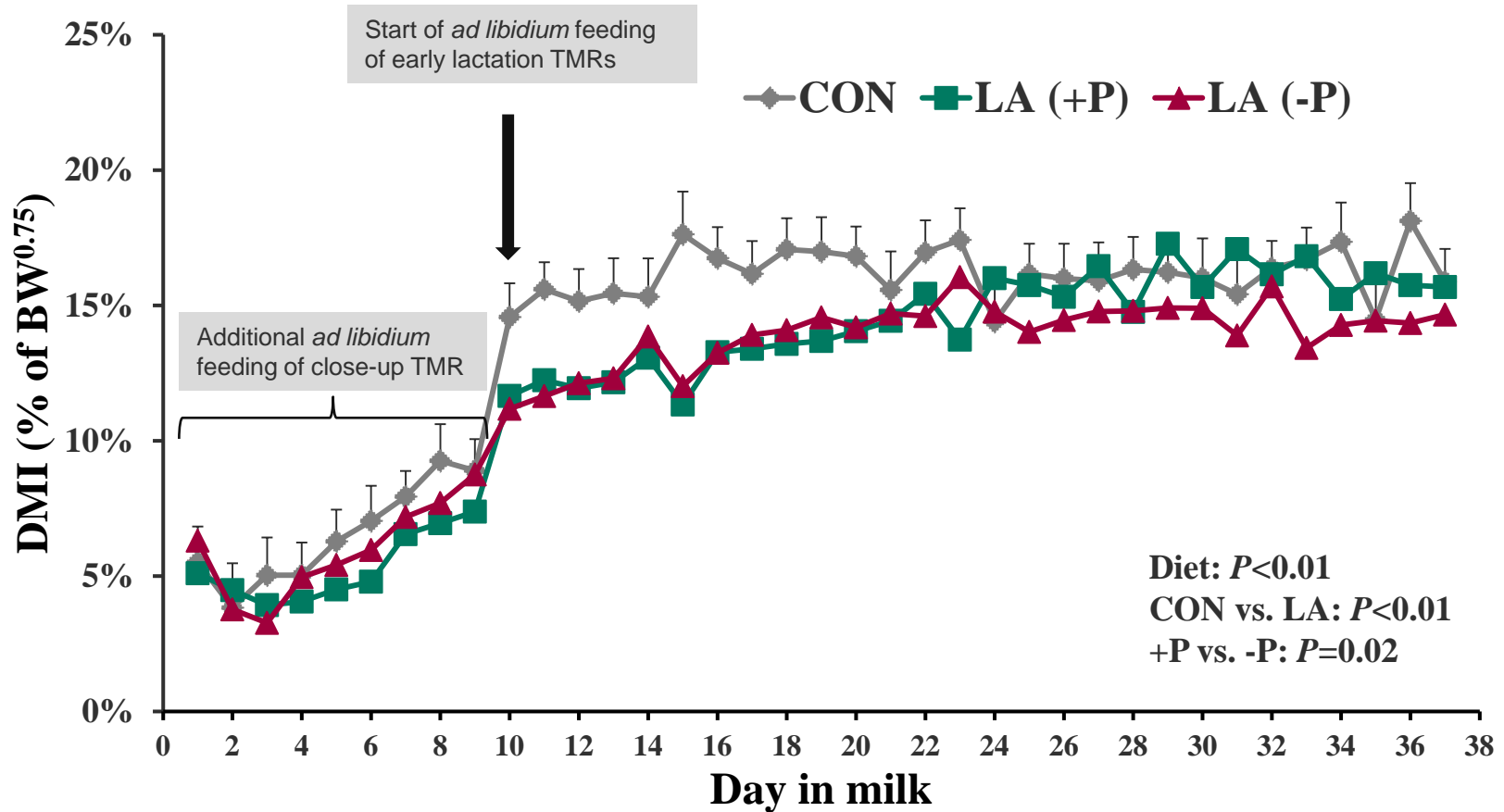
- Weekly analysis of TMRs
- Weekly determination of **body weight**
- Milked twice daily and **milk yield** recorded
- **Blood samples** collected 1 h before morning feeding on d 11, 18, 25 and 37 in milk
  - > analysis of selected blood metabolites related to glucose and lipid metabolism, liver enzymes (AST, GLDH, GGT), acute phase protein (SAA) and minerals (Ca, P)
- on d 36 and 37: 0, 2, 4, and 12 h after morning feeding
  - > analysis of diurnal variation of metabolites related to glucose and lipid metabolism as well as Ca and P



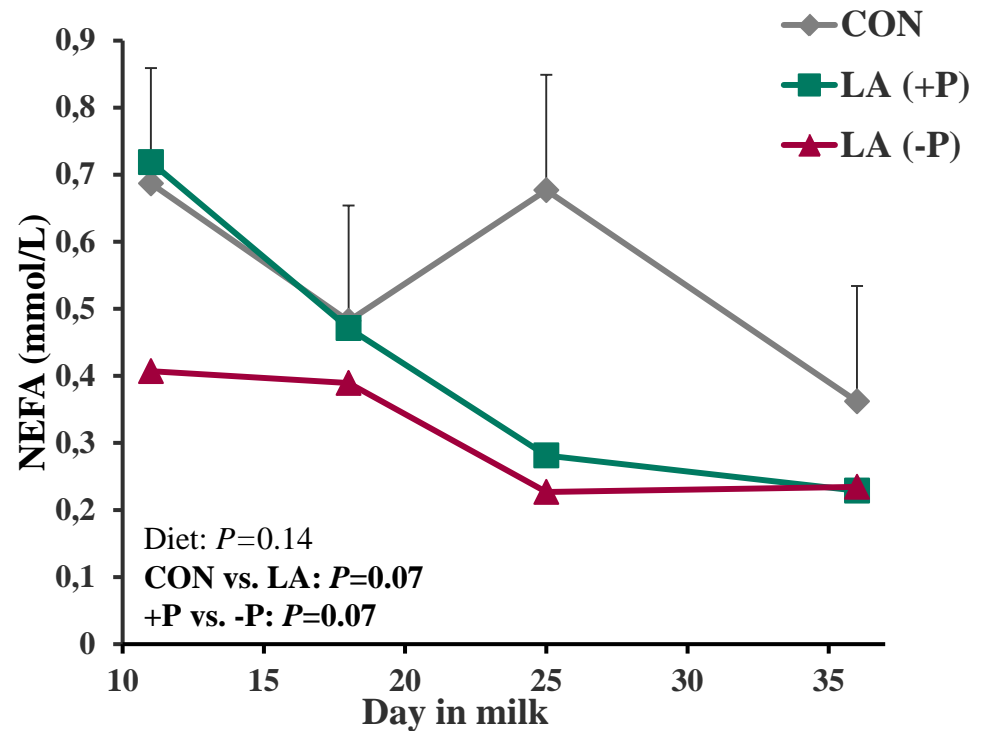
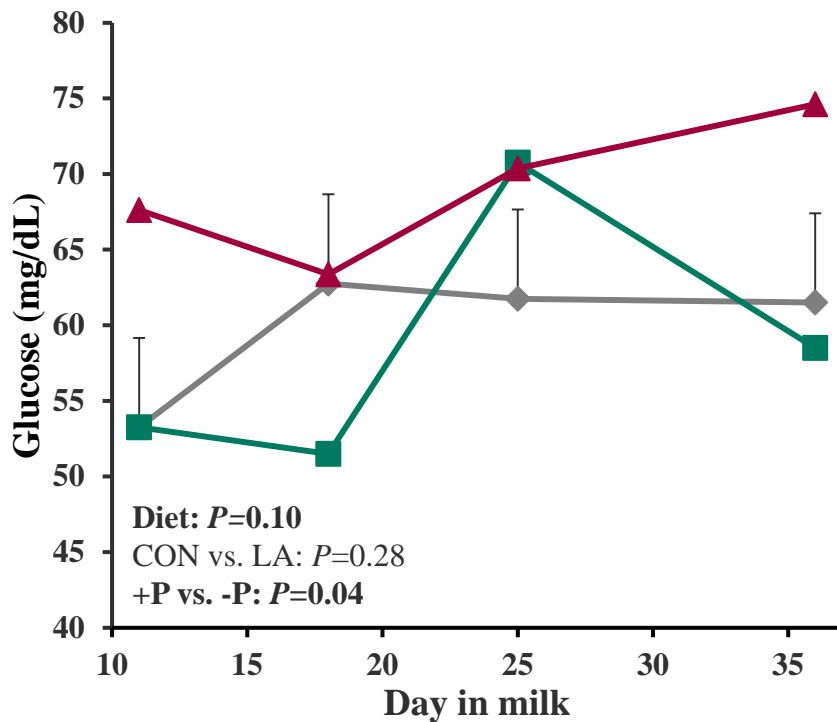
# Statistical analysis

- ANOVA, Proc MIXED (SAS, 9.2)
- **Fixed effects:** diet, time (i.e., DIM or hour relative to morning feeding), diet x time
- **Random effects:** breed, lactation number
- Data from same cow: repeated measurements (first-order autoregressive)
- Tukey`s Test for comparisons among LSM
- **Linear Contrasts:**
  - > overall effect of LA (CON vs. average of LA(+P) and LA(-P))
  - > overall effect of inorganic P supplementation ((LA(-P) vs. average of CON and LA(+P))
- Pd0.05: significance;  $0.05 < P \leq 0.10$ : trend

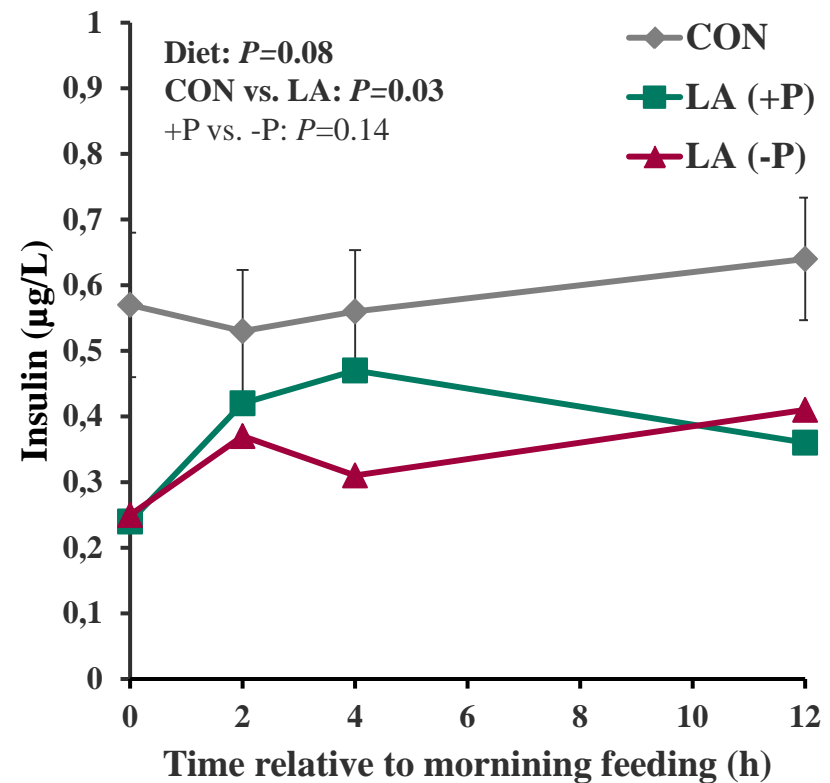
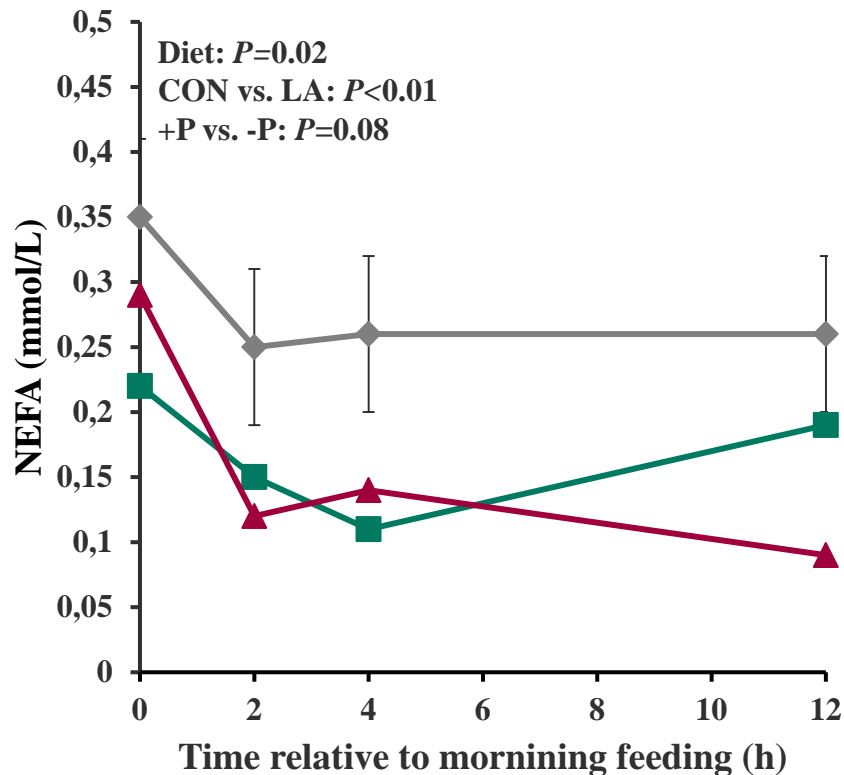
# DMI of early lactation TMRs



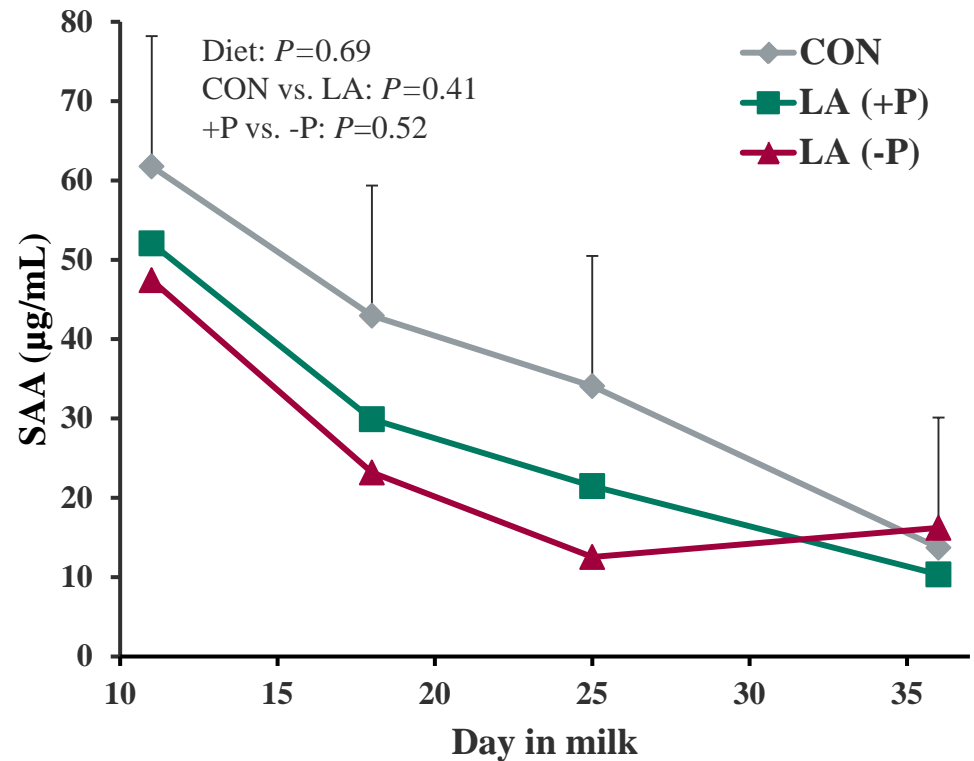
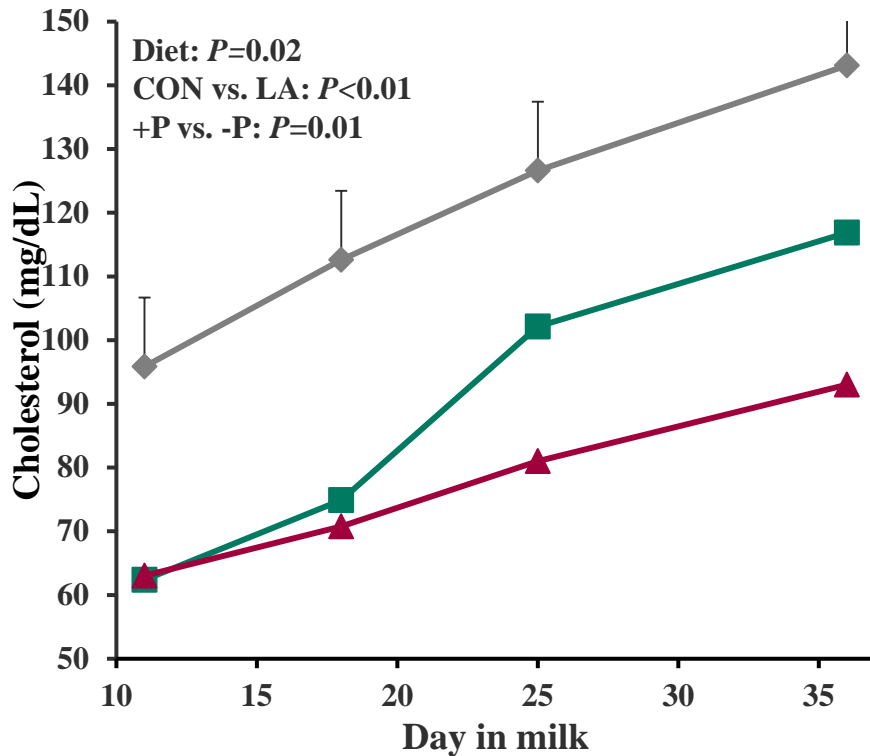
# Glucose and NEFA



# Diurnal Variation NEFA and Insulin

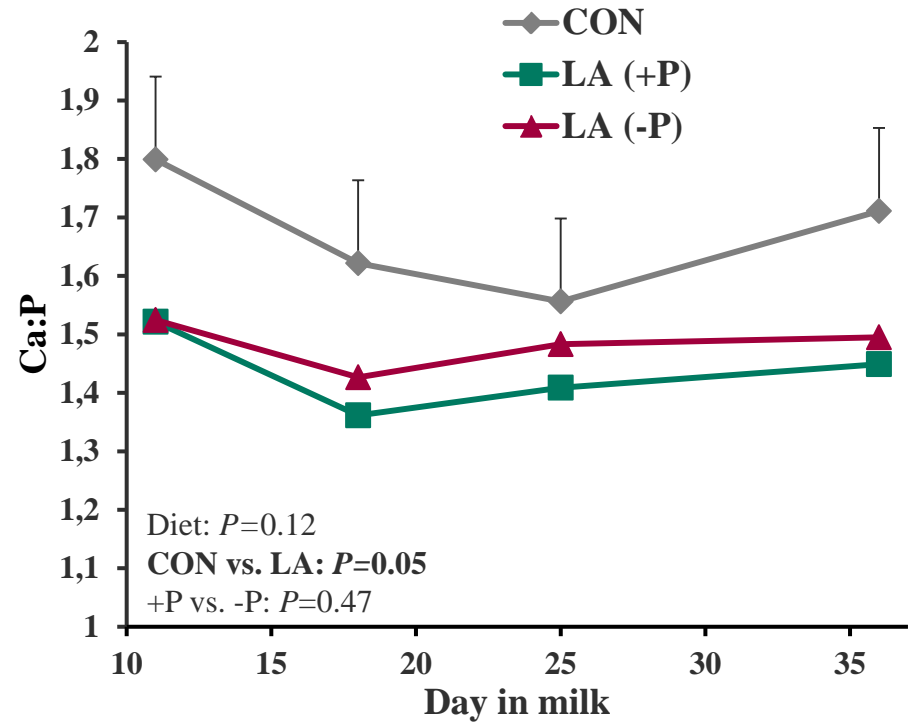
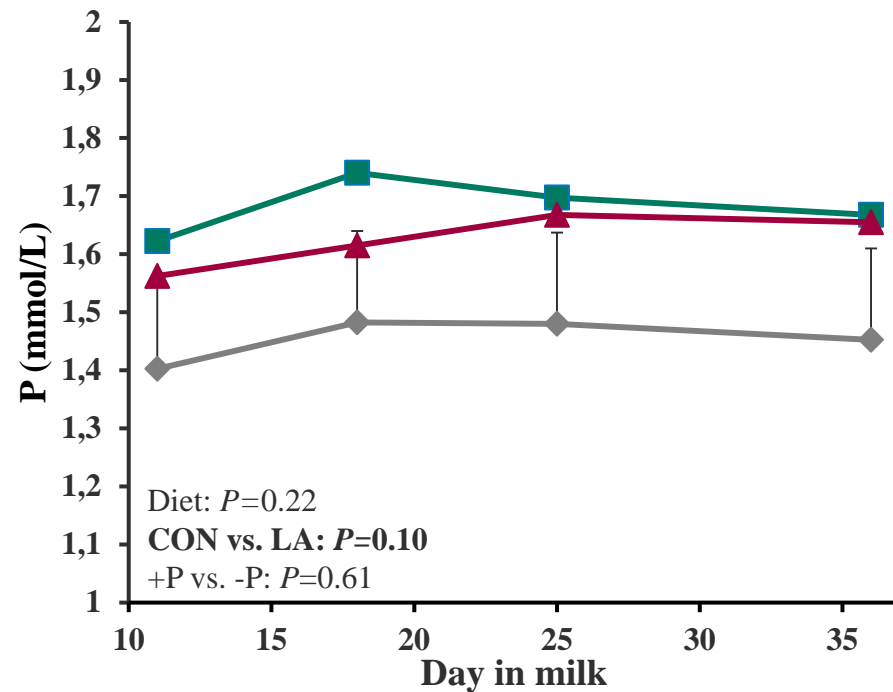


# Cholesterol and Serum Amyloid A





# P and Ca:P



# Milk Paramters and Body Weight

	Diet			SEM	P-Value <sup>1</sup>				
	CON	LA (+P)	LA (-P)		Day	Diet	Day x Diet	CON vs. LA	+P vs. -P
Milk yield, kg/d	33.4	34.9	32.4	0.59	<0.01	0.17	0.89	0.82	0.13
Milk composition, %									
Fat	3.88	4.21	3.68	0.169	0.73	0.55	0.13	0.88	0.44
Protein	3.27	3.08	3.14	0.032	0.23	0.31	0.32	0.20	0.85
➔ <b>Lactose</b>	<b>4.79<sup>a</sup></b>	<b>4.66<sup>b</sup></b>	<b>4.68<sup>ab</sup></b>	0.016	0.65	<b>0.07</b>	0.58	<b>0.02</b>	0.33
Fat:Protein	1.24	1.38	1.18	0.059	0.58	0.57	0.05	0.79	0.48
SCC, cells/mL	41,769	24,685	33,984	10,417	0.32	0.35	0.26	0.23	0.94
MUN, mg/dL	38.4	38.4	36.4	0.582	0.03	0.43	0.13	0.45	0.20
Milk pH	6.54	6.52	6.53	0.012	0.88	0.95	0.54	0.75	0.93
BW, kg	745.3	700.8	701.4	10.61	<0.01	0.35	0.90	0.16	0.41
BW change, kg	-26.6	-26.4	-23.2	3.79	<0.01	0.98	0.49	0.91	0.83

# Conclusions

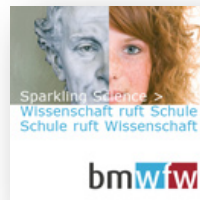
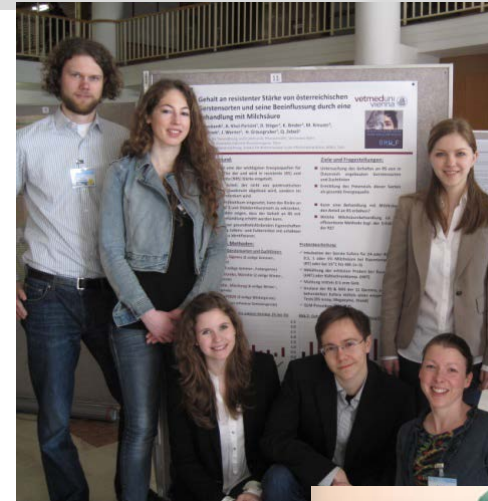
**Feeding early-lactating cows concentrates steeped in 5% LA with or without inorganic P supplementation:**

- impaired DMI during the first 2 weeks of *ad libitum* feeding
- did not affect milk production or body weight
- lowered serum NEFA, insulin and cholesterol  
-> **improved energy status**
- tended to increase serum P  
-> **potential to save inorganic P supplements**



# Acknowledgments

- Team of Animal Nutrition at Vetmeduni Vienna
- Staff of research station Kremesberg (Vetmeduni)
- Funders:
  - „optGerste“
  - „functional feed for cows“








*Thank you very much for your attention!*





# Further Blood Analysis

	Diet			SEM	P-Value				
	CON	LA (+P)	LA (-P)		Day	Diet	Day x Diet	CON vs. LA	+P vs. -P
BHB, mmol/L	0.52	0.61	0.51	0.039	0.37	0.70	0.42	0.81	0.63
Lactate, mmol/L	0.69	0.76	0.72	0.026	0.24	0.80	0.24	0.57	0.99
BUN, mg/dL	36.7	34.3	36.9	0.83	<0.01	0.39	0.79	0.56	0.48
TP, g/dL	7.27	7.11	7.37	0.071	0.28	0.59	0.98	0.90	0.41
Ca, mmol/L	2.36	2.38	2.39	0.021	0.22	0.87	0.84	0.61	0.70
 AST, U/L	<b>71.4<sup>b</sup></b>	<b>90.2<sup>a</sup></b>	<b>63.8<sup>b</sup></b>	3.364	0.02	<b>&lt;0.01</b>	<b>0.05</b>	0.35	<b>0.01</b>
GLDH, U/L	21.92	14.44	8.41	1.566	0.47	0.29	0.34	0.13	0.17
 GGT, U/L	<b>22.3<sup>a</sup></b>	<b>23.4<sup>a</sup></b>	<b>15.7<sup>b</sup></b>	0.567	0.03	<b>&lt;0.01</b>	0.98	0.15	<b>&lt;0.01</b>
Bilirubin, mg/dL	0.109	0.122	0.069	0.011	0.04	0.18	0.60	0.54	<b>0.08</b>
 Bile acids, $\mu\text{mol/L}$	<b>58.6<sup>a</sup></b>	<b>42.1<sup>ab</sup></b>	<b>28.5<sup>b</sup></b>	4.221	0.96	<b>0.02</b>	0.56	<b>0.01</b>	<b>0.01</b>