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Effects of protein reduction on performance, rumen metagenome and metabolic profile in Holstein calves

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INTRODUCTION

- High concentrate diets for beef calves in the Mediterranean region (90% concentrate: 10% forage).
- Current CP recommendations: 16-18% (DM) for growing calves.

INTRODUCTION

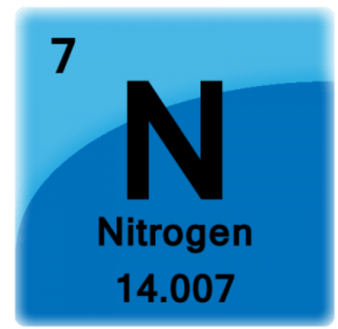
- Some studies obtained similar ADG and less N waste when reducing CP content to 12-14% (DM).
- Adaptation due to: animal's metabolism or rumen microbiota.

POSSIBLE OVERESTIMATION

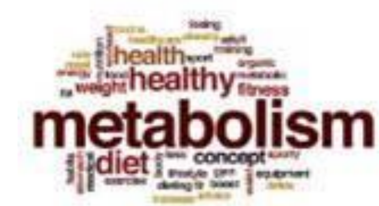
CONTROVERSIAL RESULTS

OBJECTIVE

- Study the effect of reducing CP supply from 14% to 12% (DM) in growing calves.



- Assessing its impact on:
  - Performance.
  - Nitrogen balance.
  - Rumen microbiota.
  - Metabolic profile.



MATERIAL AND METHODS

- Twenty male Holstein calves (118±1 days of age and 162±5 kg of body weight).
- Two experimental treatments:
  - CTR: Commercial concentrate (CP: 14% [DM]) plus barley straw.
  - LP: Low protein concentrate (CP: 12% [DM]) plus barley straw.

***AD LIBITUM* FED**
FREE ACCESS TO WATER

MATERIAL AND METHODS

- Live weight and concentrate intake automatically registered throughout the experimental period.

MATERIAL AND METHODS

- Sampling in week 6 of experimental period:
  - Nitrogen balance:

N retention = N intake – N urine – N faeces

  - Rumen microbial community:

Taxonomic profiling of 16S ribosomal RNA

  - Metabolic profile:

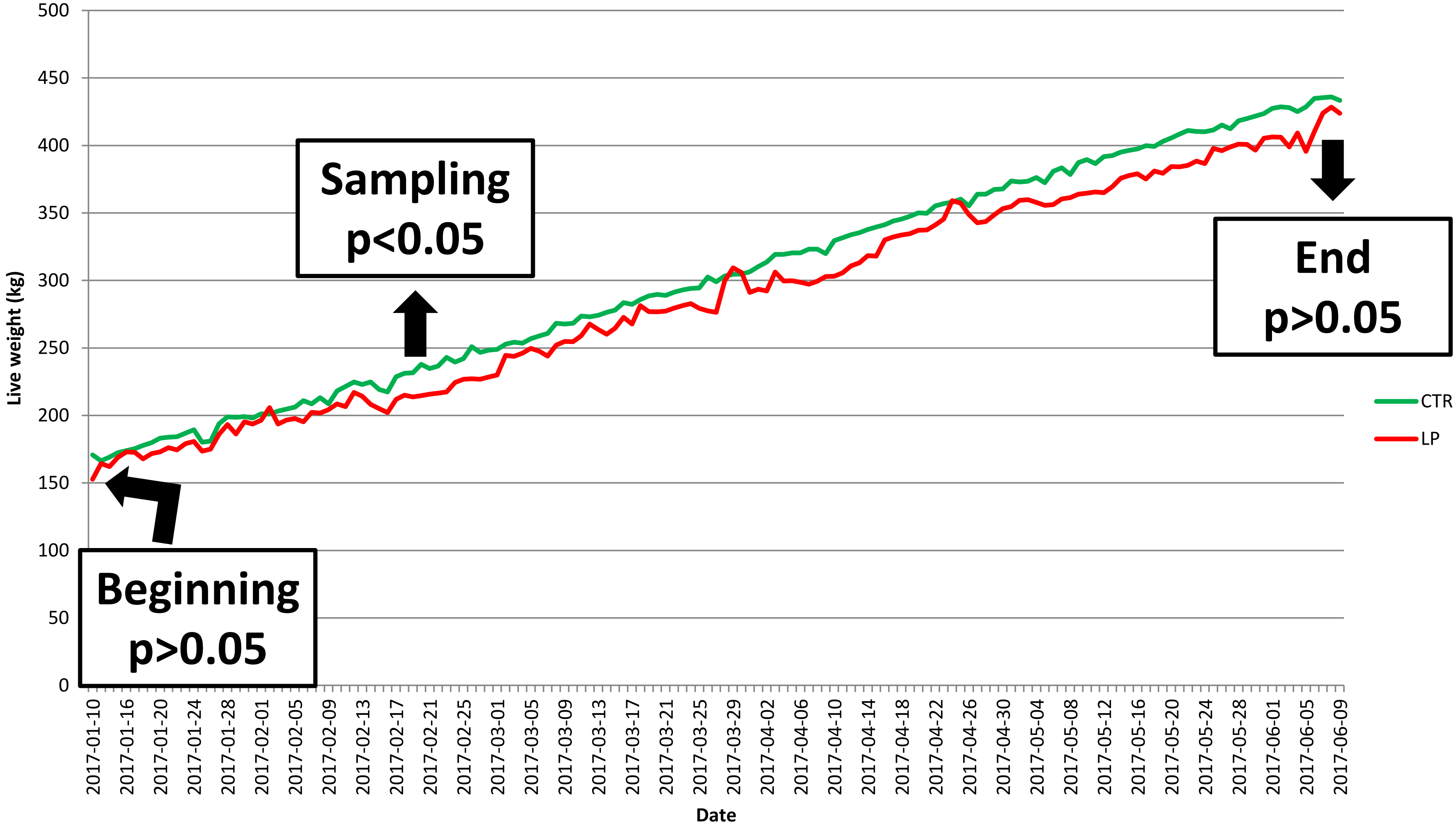
All metabolites and plasma and urine

RESULTS: PERFORMANCE

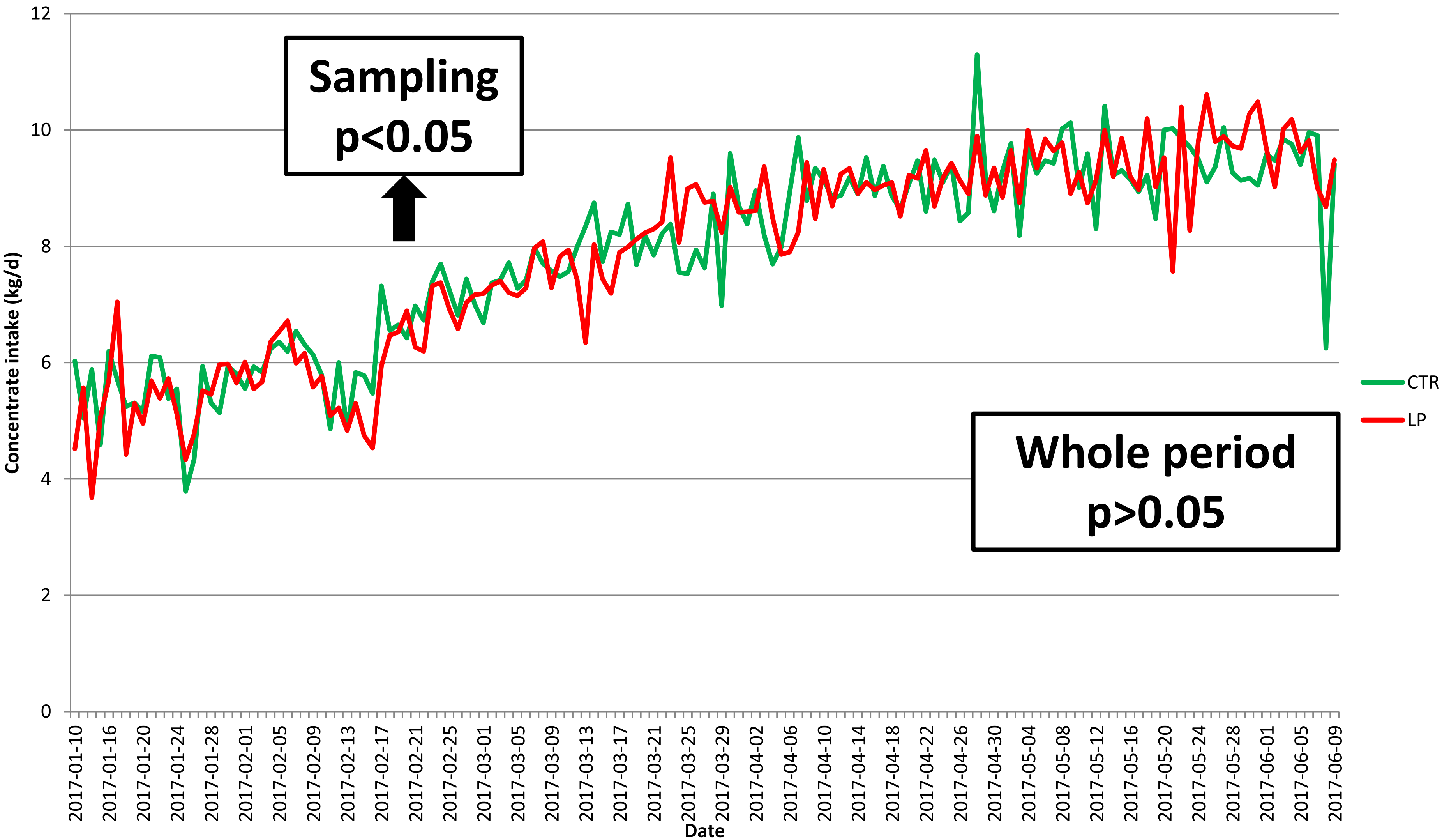
	CTR	LP	SE
n	10	10	
Live weight (kg)	234.7^{a}	214.8^{b}	6.00
ADG (kg/d)	1.8	1.5	0.06
Concentrate intake (kg/d)	6.6^{a}	5.7^{b}	0.22
Concentrate conversion index	3.7	3.7	0.14

Week 6 Sampling

RESULTS: PERFORMANCE



RESULTS: PERFORMANCE



Week 6
Sampling

RESULTS:
NITORGEN BALANCE

	CTR	LP	SE
n	10	10	
N intake (g/d)	152.3[a]	113.8[b]	4.52
N excreted in urine (g/d)	28.7	18.7	4.16
N excreted in faeces (g/d)	54.5[a]	45.8[b]	1.82
N retention (g/d)	69.0[a]	49.2[b]	4.73
N retention (% N intake)	45.5	43.3	3.12

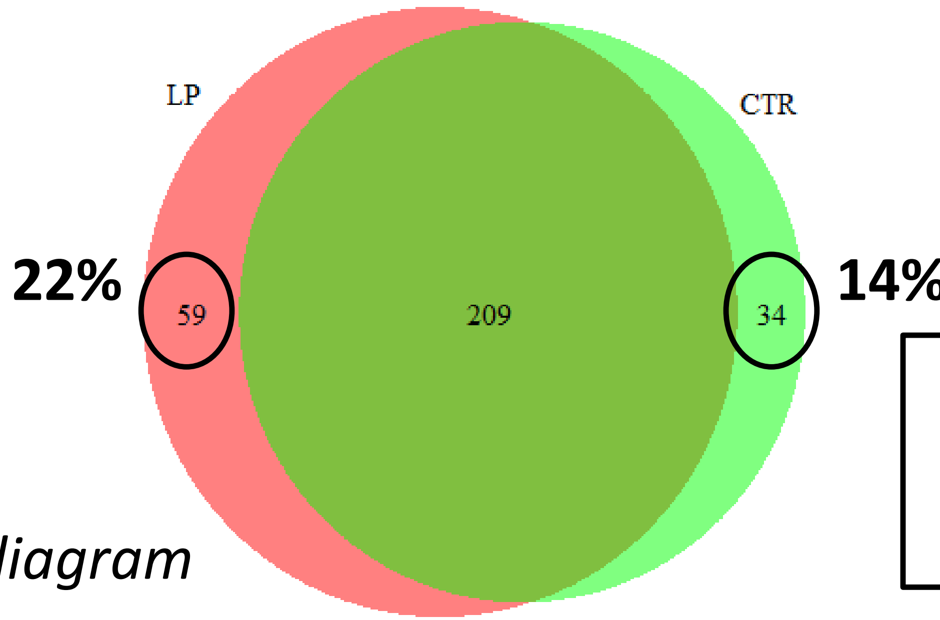
Week 6
Sampling

RESULTS: RUMEN MICROBIOTA

	CTR	LP	SE
n	10	10	
NH_3-N (mg/L)	4.15[a]	0.58[b]	1.185
pH	7.29	7.28	0.126
VFA (mmol/L)	66.96	57.81	8.512
Acetate (%)	46.30	47.79	0.887
Propionate (%)	43.59[a]	39.46[b]	0.734
Butyrate (%)	6.42[b]	9.27[a]	0.198

Week 6
Sampling

RESULTS:
RUMEN MICROBIOTA



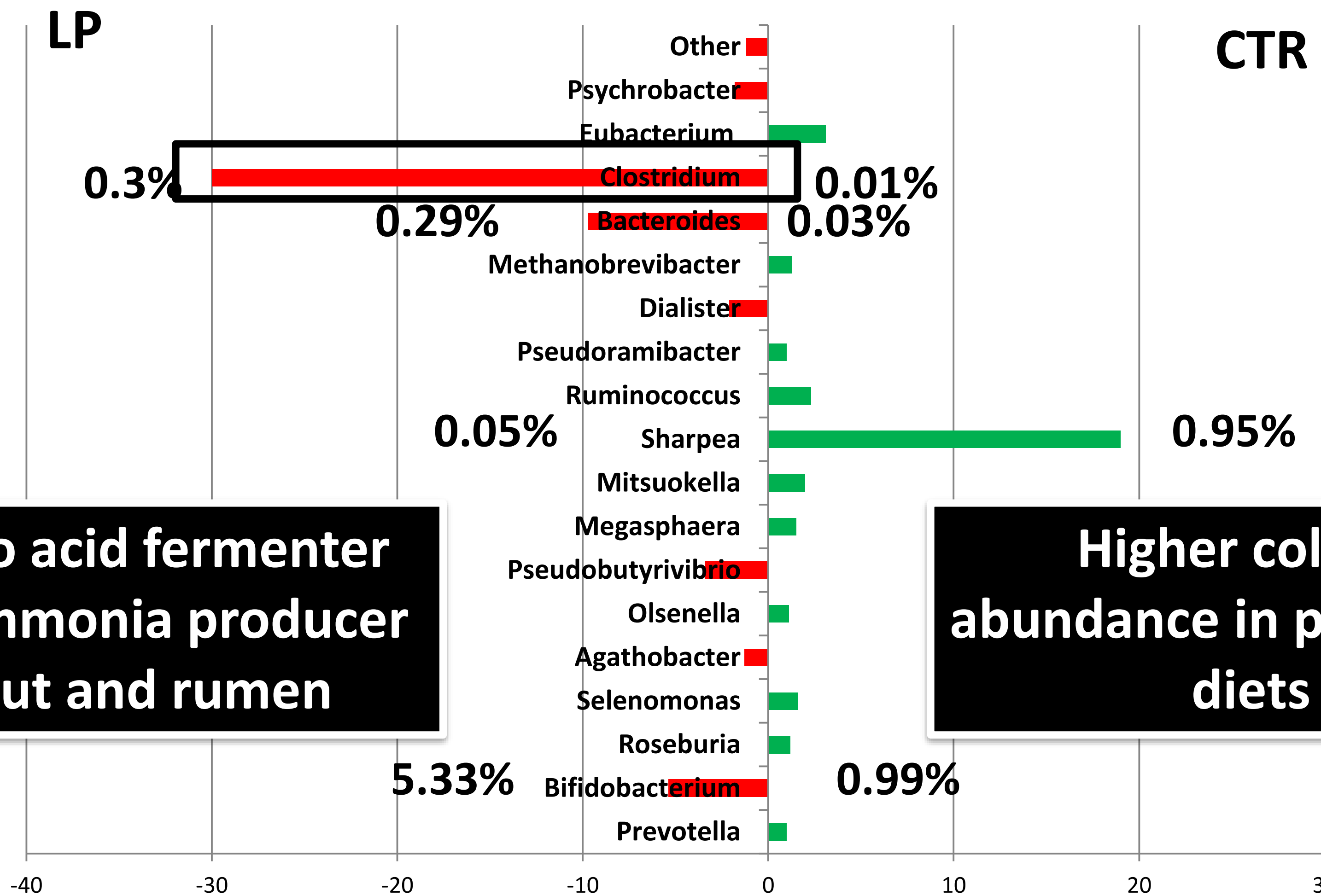
Venn diagram

Protein intake reduction raised rumen microbial diversity levels

	CTR	LP	SE
n	10	10	
Shannon Index	1.0^b	1.7^a	0.12
Simpson Index	0.3^b	0.6^a	0.04
Richness (OTUs/animal)	101.4^b	129.9^a	7.78

Week 6
Sampling

RESULTS:
RUMEN MICROBIOTA



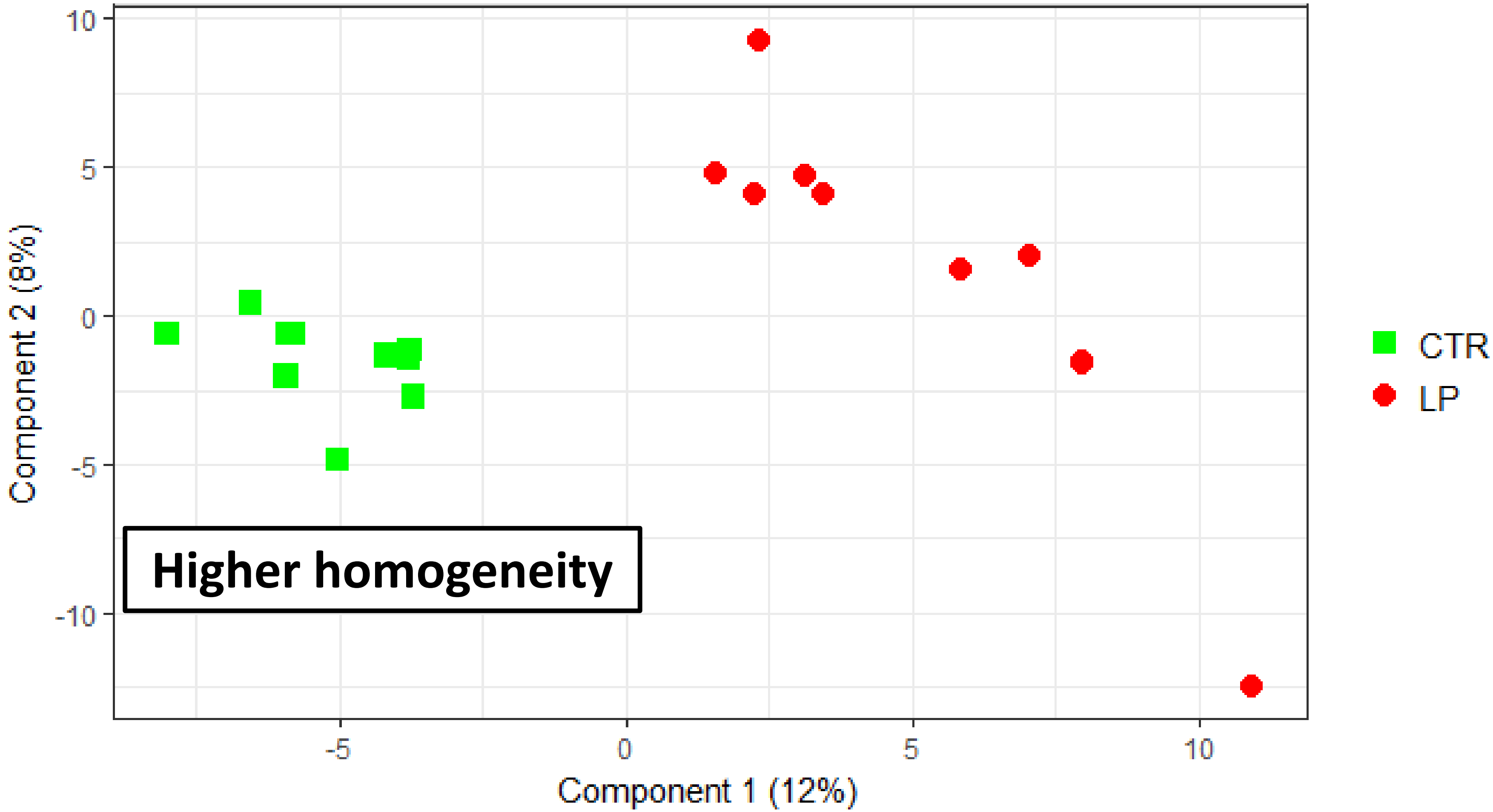
Amino acid fermenter and ammonia producer in gut and rumen

Higher colonic abundance in pigs fed LP diets

Fold change in genera abundance

Week 6 Sampling

RESULTS: RUMEN MICROBIOTA

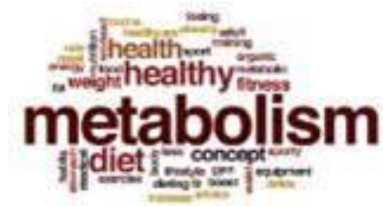


Rumen microbiota composition was modified by experimental treatment

Partial least-squares discriminant analysis

Week 6
Sampling

RESULTS: METABOLIC PROFILE

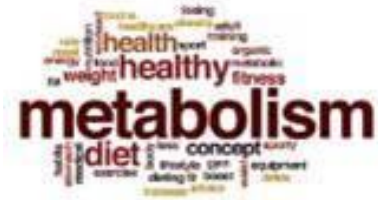


	Total detected metabolites	Discriminant metabolites
n	10	10
Urine (negative ionization)	1,555	139
Urine (positive ionization)	1,075	120
Plasma (negative ionization)	171	31
Plasma (positive ionization)	412	20
TOTAL	**3,213**	**310**

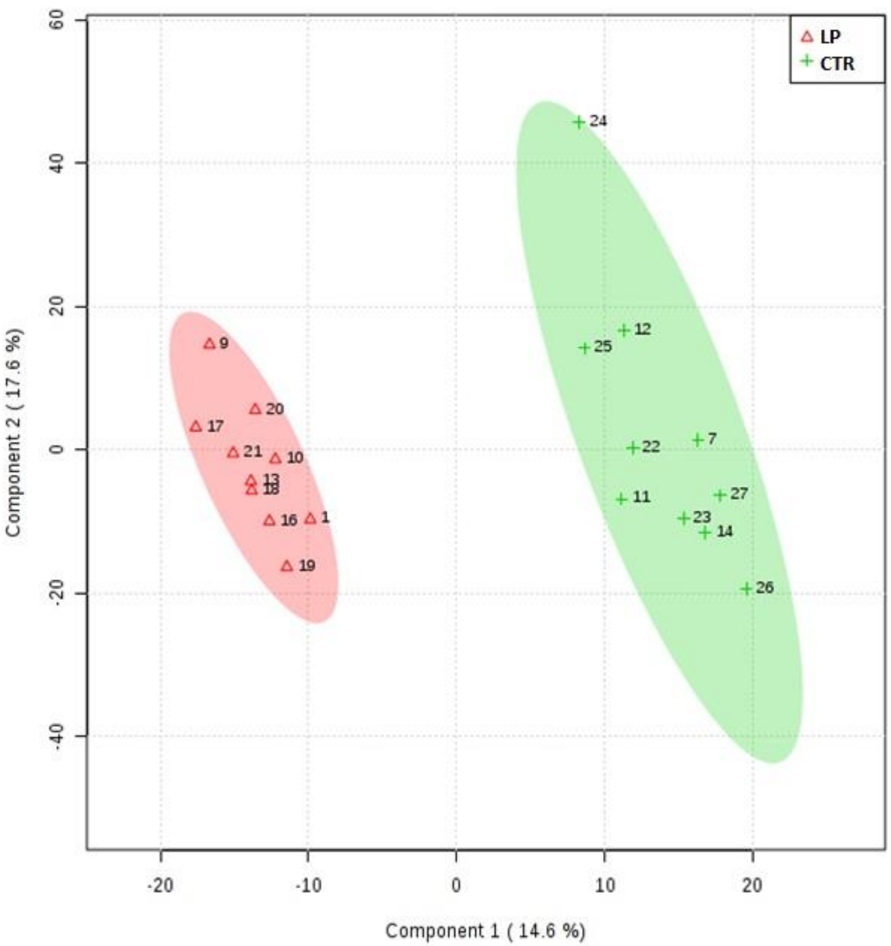
Protein reduction effect?

Week 6
Sampling

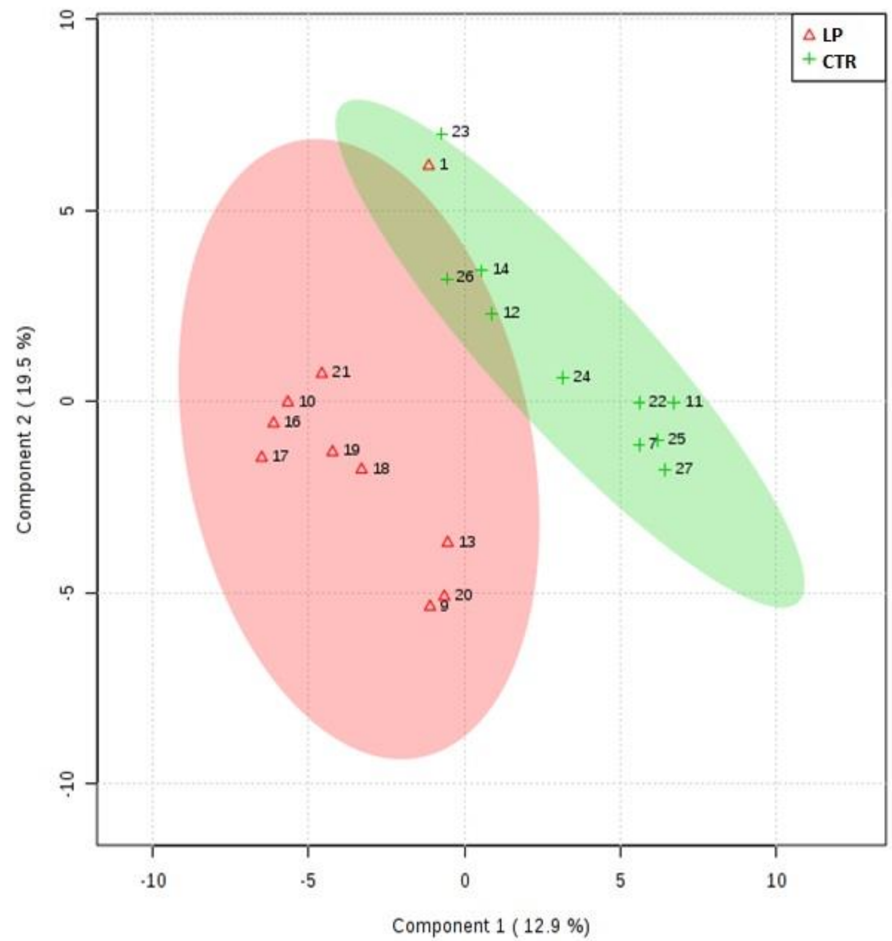
RESULTS: METABOLIC PROFILE



Urine



Plasma



Partial least-squares discriminant analysis

Week 6
Sampling

CONCLUSIONS

Similar performance results in the entire experimental period

- Dietary protein reduction led to:
  - Lower dry matter intake and performance.
  - Lower nitrogen retention and waste.
  - Higher ruminal microbiota biodiversity.

Evidence of rumen microbiota adaptation to a low protein diet?

  - New metabolites appearance.

Different metabolic pathways to cope with a low protein diet?

THANK YOU FOR YOUR ATTENTION!