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Effect of condensed tannins from legumes on nitrogen balance and ruminal fermentation in dairy cows

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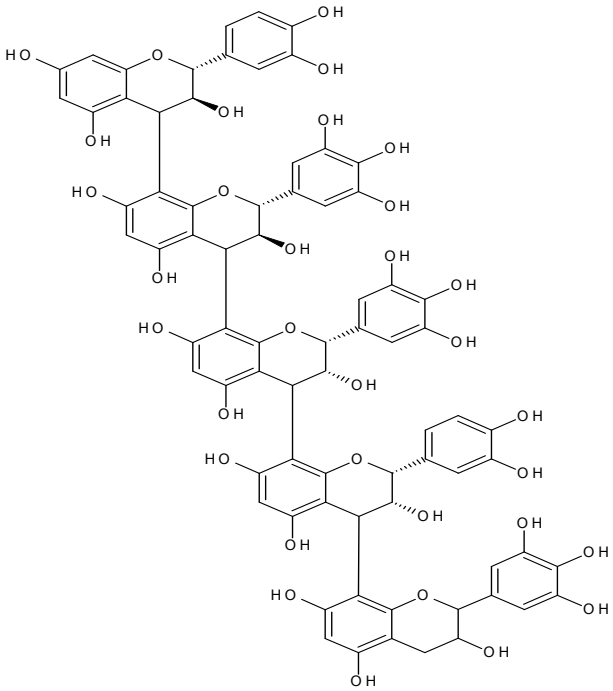
LegumePlus
Marie Curie Initial Training Network

MARIE CURIE ACTIONS

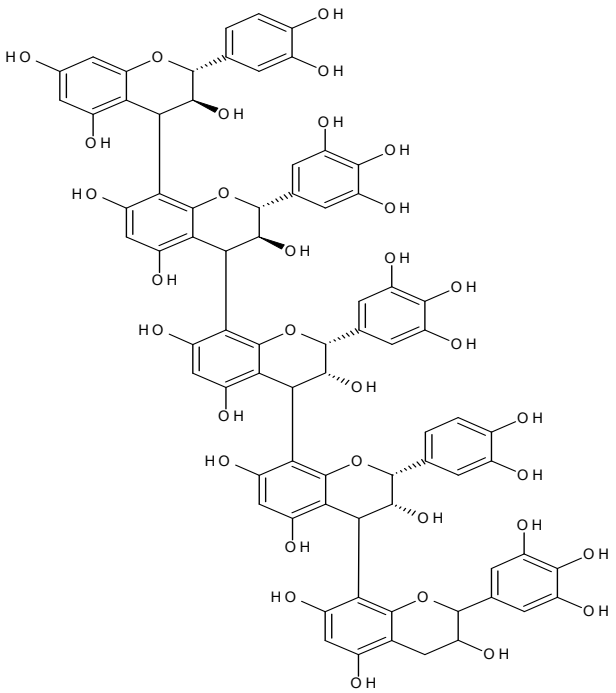
Background



Sainfoin and Birdsfoot trefoil contain **condensed tannins (CT)**, which form complexes with proteins

→decrease protein degradation in the rumen (Mueller-Harvey, 2006)

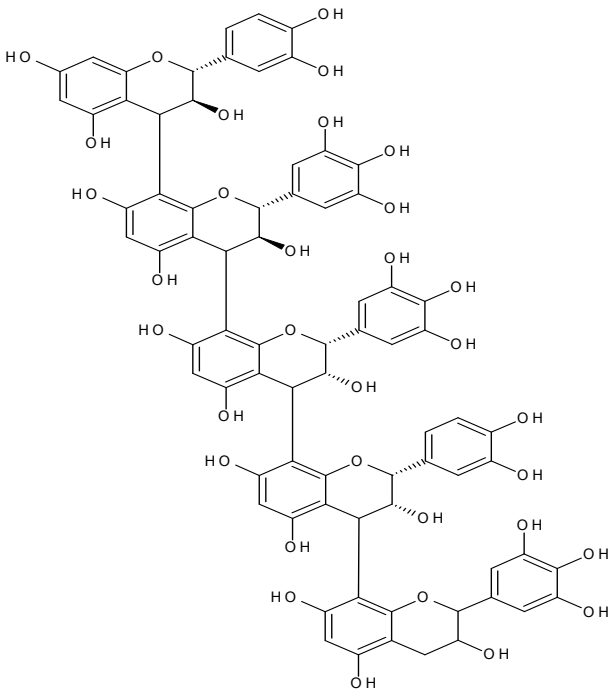
Hypotheses



CT in Sainfoin and Birdsfoot trefoil

- Will **decrease protein degradation** in the rumen by forming complexes and increase the rumen escape protein
- Will **lower the N excretion** in the urine due to lower NH_3 concentrations in the rumen
- Will **lower the VFA concentration** in the rumen by forming complexes with carbohydrates
- Will **change the microbial profile** in the rumen by changing the resources for the microbes

Objectives



We wanted to determine the effect of condensed tannins from Sainfoin and Birdsfoot trefoil

1. on the nitrogen (N) balance

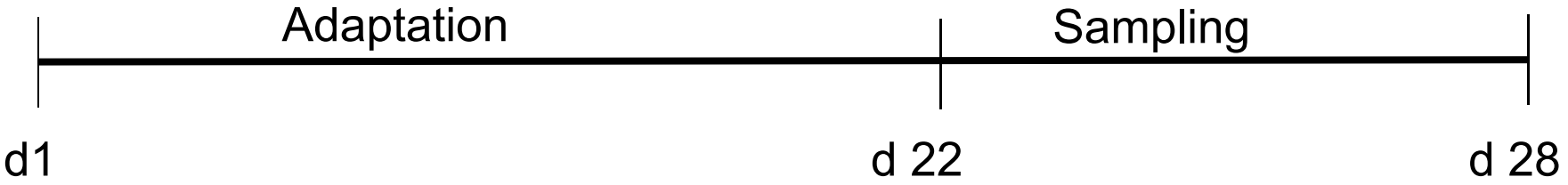
2. on ruminal fermentation

in dairy cows

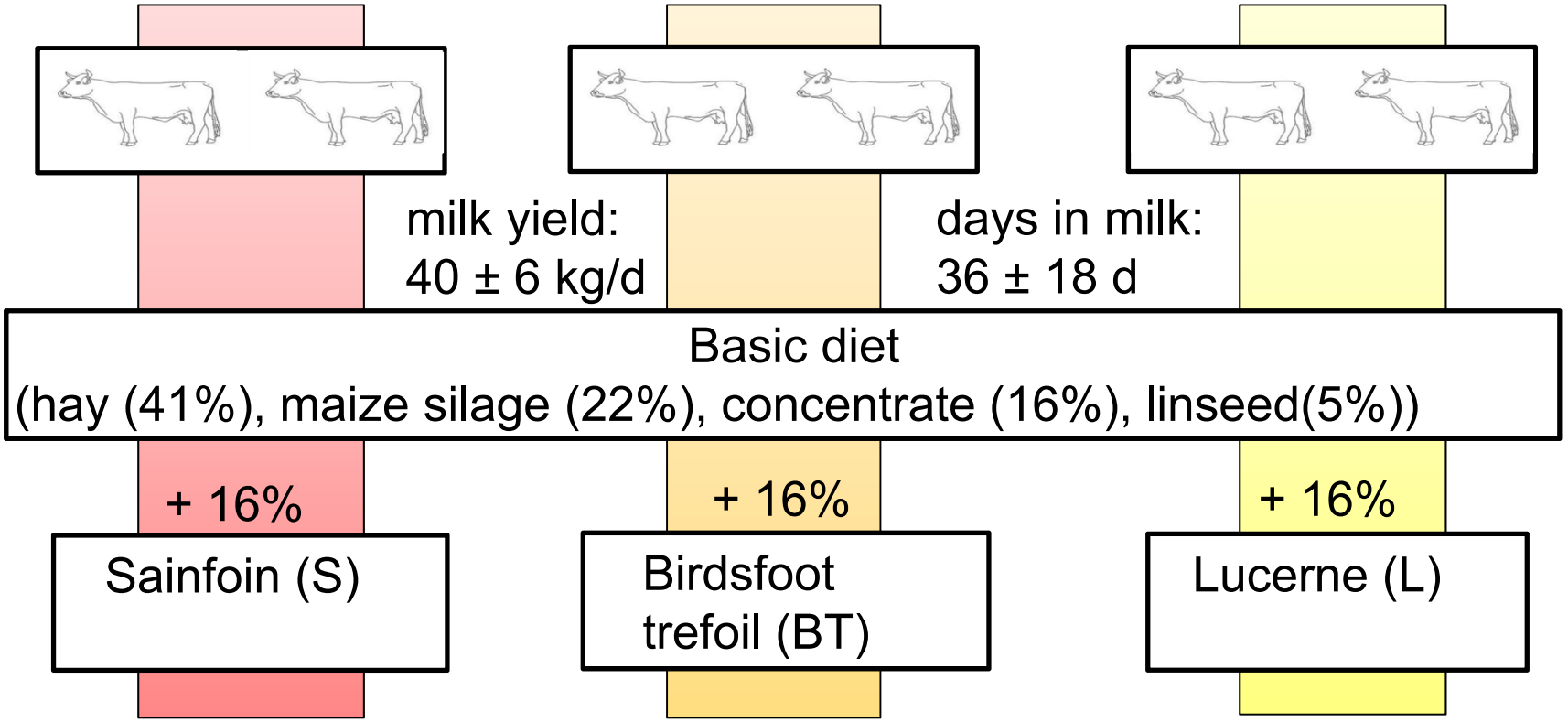
Materials and Methods

Design: 3 x 3 Latin square

Sampling days: 23 & 27
Sampling time: 0700 & 1700



Materials and Methods



Materials and Methods

Condensed tannin content and composition

	Sainfoin	Birdsfoot trefoil	Lucerne
Total g/kg DM	223	29	-
Extractable	142	11	-
Protein-bound	65	14	-
Fibre-bound	16	4	-

Materials and Methods - collected data

Feed intake
Performance
- milk yield
- milk fat
- milk protein

N flow
N-balance
- N in urine
- N in faeces
- N in milk
- urea in blood, milk and urine

Fermentation products
- volatile fatty acids (VFA)
- ammonia (NH_3) in the rumen fluid

Quantitative determination via qPCR of
- *Butyrivibrio fibrisolvens*
- *Ruminococcus flavefaciens*
- *Prevotella spp.*

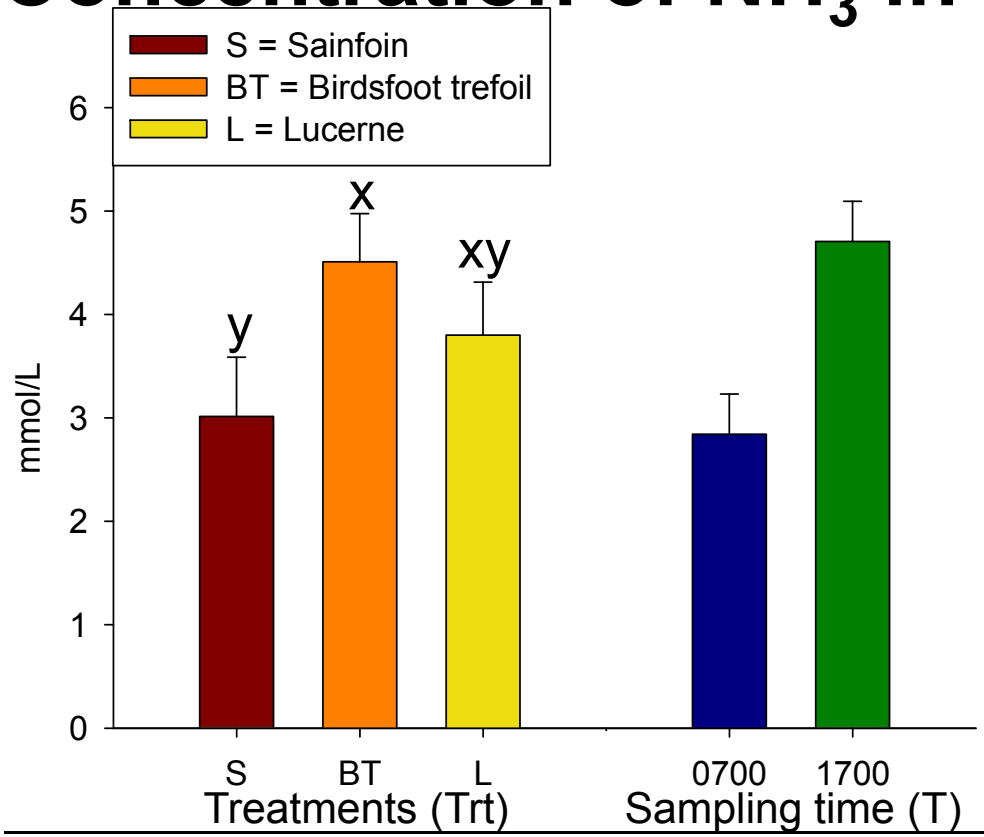
Feed intake and performance

Feed intake and performance of dairy cows (n = 6)

	Sainfoin	Birdsfoot trefoil	Lucerne	SEM	P-Value
Total DM intake, kg/d	21.2	21.2	21.6	1.3	0.82
Total intake of CT g/d	754[a]	107[b]	n.a.	31.4	<0.01
Milk yield, kg/d	38	37	38	2.5	0.65
Milk fat, %	3.87	3.95	4.00	0.24	0.32
Milk protein, %	2.89[a]	3.11[b]	2.96[ab]	0.09	0.02

Means within a row with different superscripts are significantly different (P<0.05)

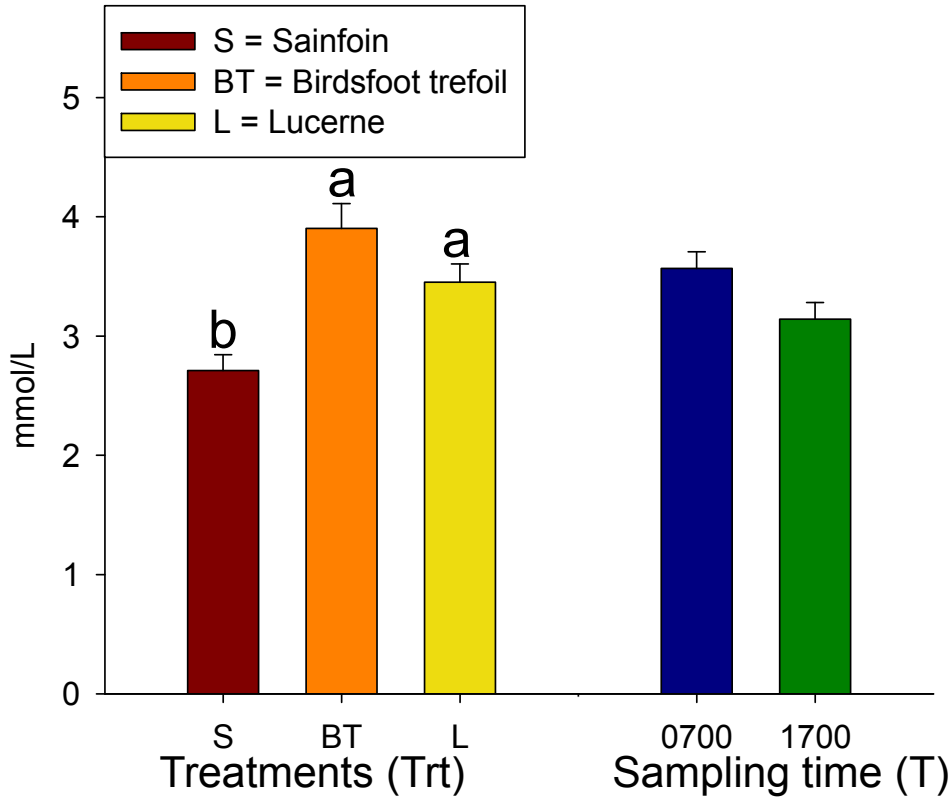
Concentration of NH_3 in the rumen



Trt : P = 0.10
T : P < 0.01
Trt x T : P = 0.52

Bars with unequal superscripts are by trend different

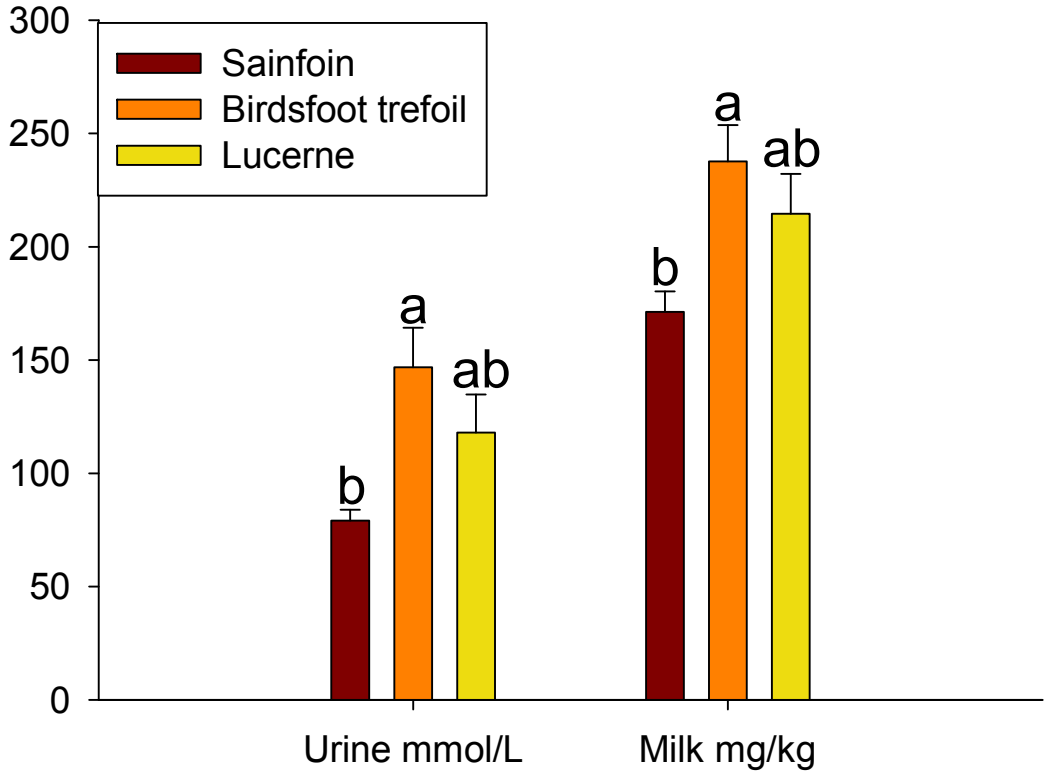
Concentration of urea in the blood



Trt : P < 0.01
T : P = 0.04
Trt x T : P = 0.80

Bars with unequal superscripts are significantly different (P<0.05)

Concentration of urea in urine and milk



Urine : P = 0.02
Milk : P = 0.01

Bars with unequal superscripts are significantly different (P<0.05)

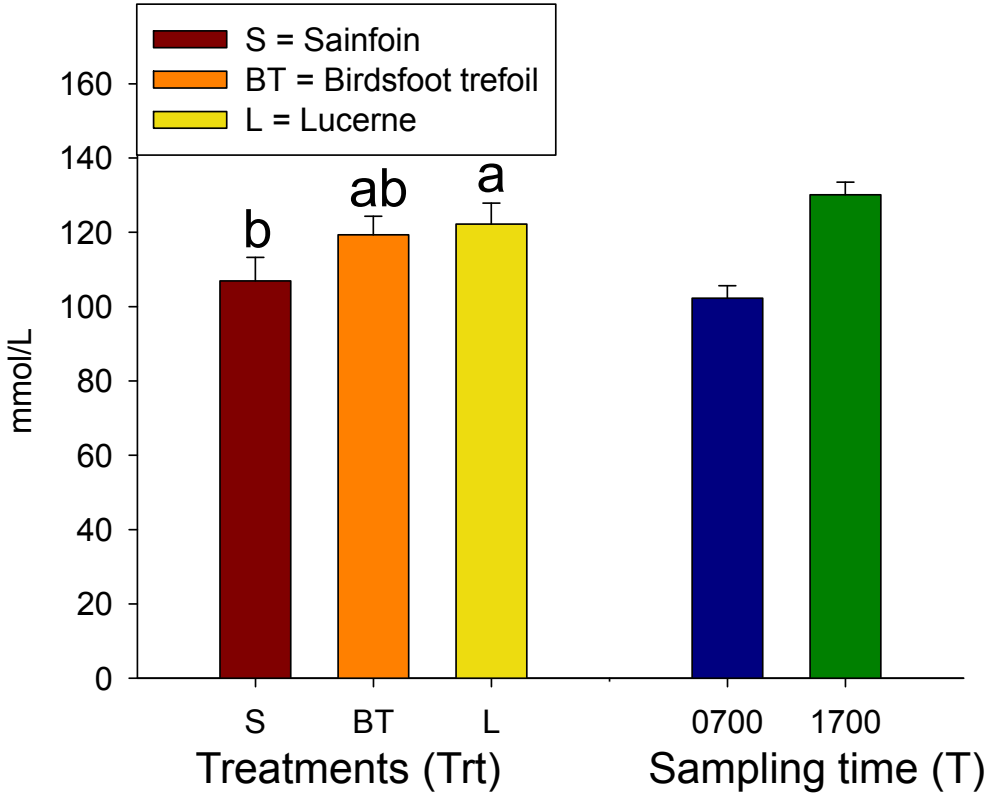
N-balance

N-balance of dairy cows (n = 6)

	Sainfoin	Birdsfoot trefoil	Lucerne	SEM	P-Value
N intake, g/d	459	493	479	28.7	0.21
N excretion					
in faeces, g/d	207	192	199	28.8	0.28
in urine, g/d	79^{a}	94^{ab}	98^{b}	8.0	0.04
in milk, g/d	173	179	173	15.9	0.59
total, g/d	458	464	470	41.0	0.65
N retention, g/d	1^{y}	29^{x}	9^{xy}	15.5	0.06

^{a,b}Means within the same row with unequal superscripts are significantly different (P<0.05)
^{x,y} Means within the same row with unequal superscripts differ by trend

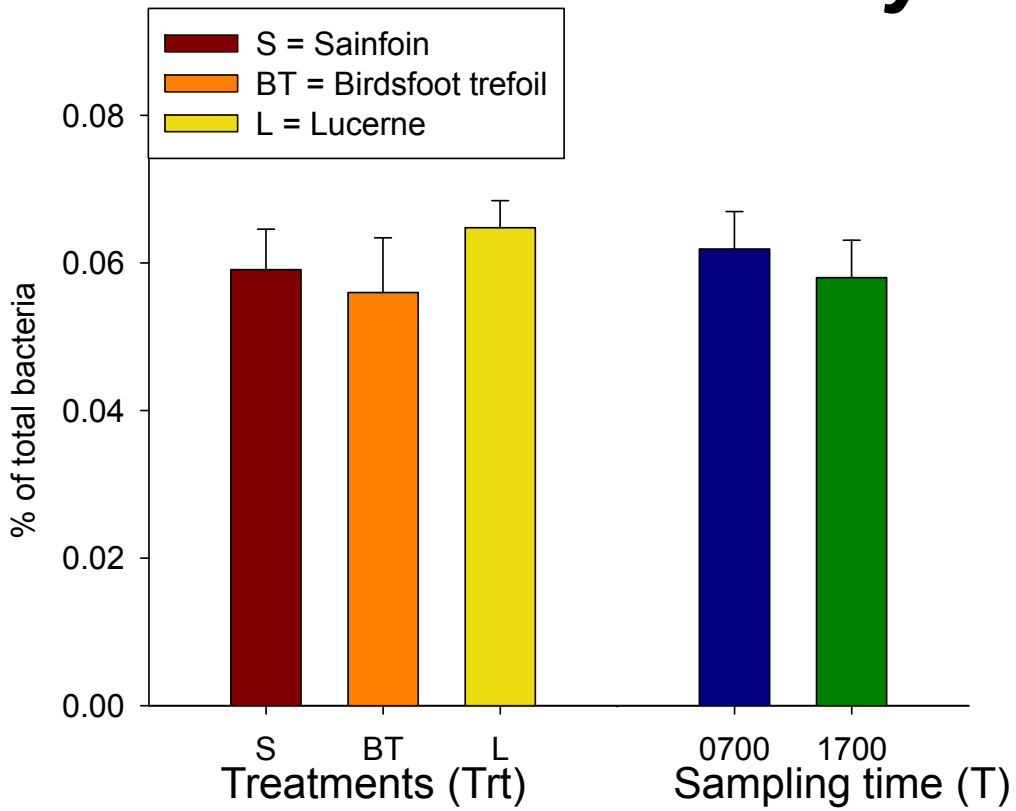
Concentration of total VFA in the rumen



Trt : P = 0.03
T : P < 0.01
Trt x T : P = 0.25

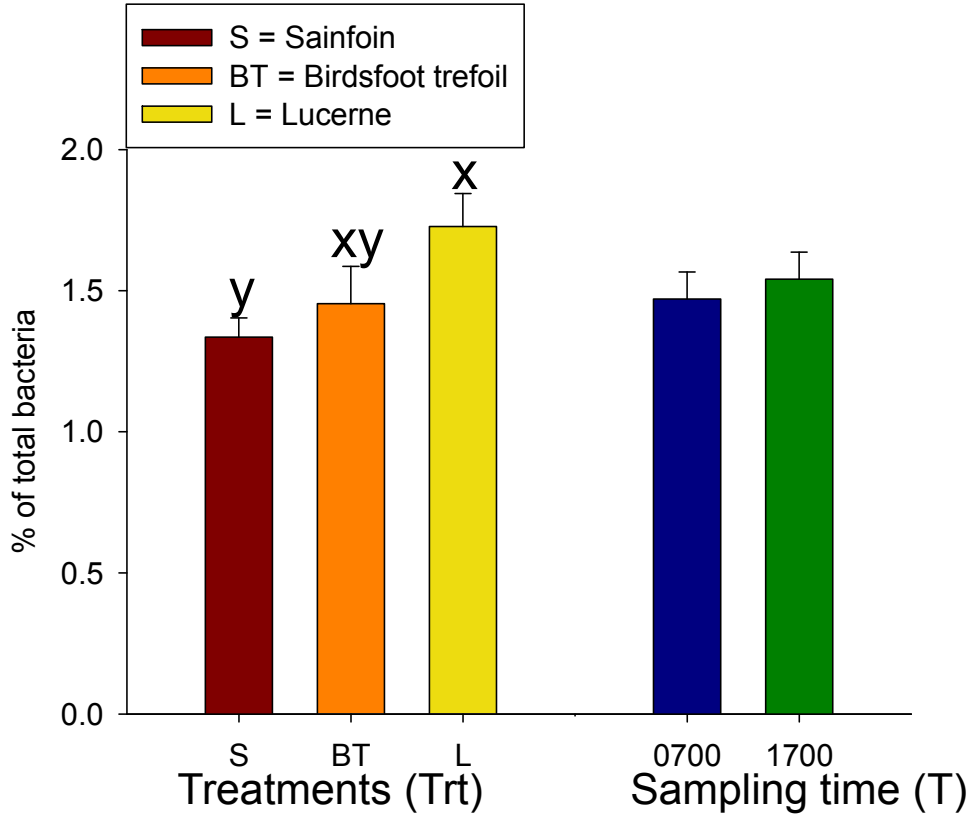
Bars with unequal superscripts are significantly different (P<0.05)

Relative amount of *Butyrivibrio fibrisolvens*



Trt : P = 0.60
T : P = 0.59
Trt x T : P = 0.83

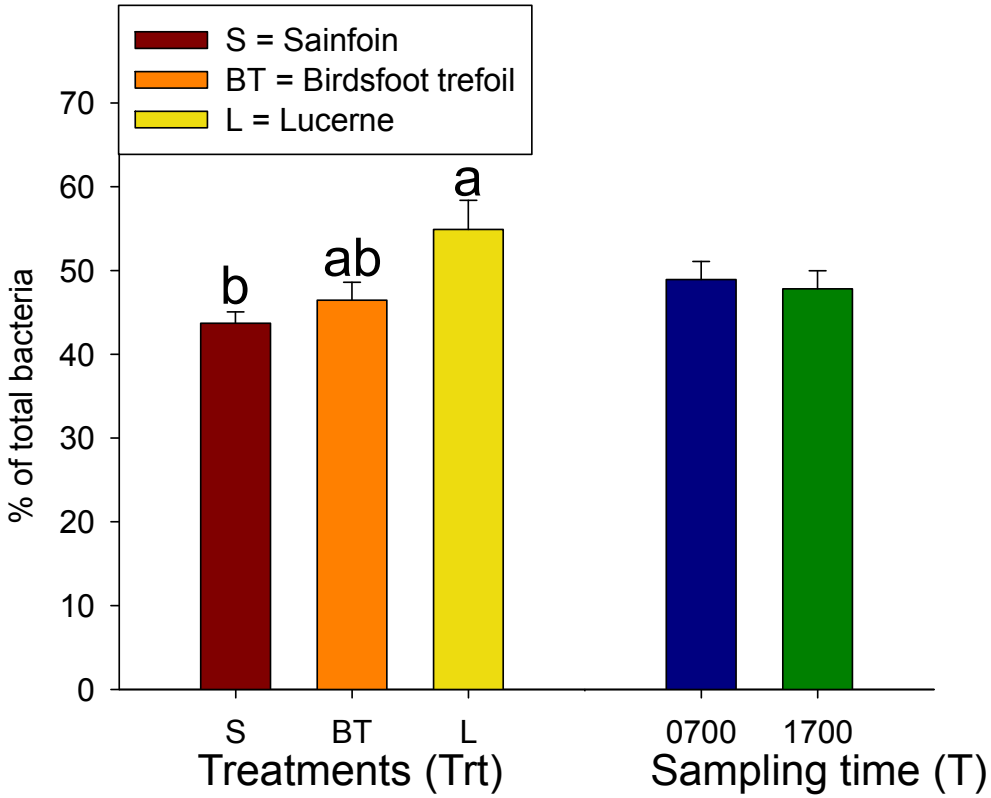
Relative amount of *Ruminococcus flavefaciens*



Trt : P = 0.07
T : P = 0.61
Trt x T : P = 0.73

Bars with unequal superscripts are by trend different

Relative amount of *Prevotella spp.*



Trt : P = 0.02
T : P = 0.72
Trt x T : P = 0.56

Bars with unequal superscripts are significantly different (P<0.05)

Summary and conclusion

Ruminal concentration of NH_3 tended to be lower with SF

→ **Decreased protein degradation in the rumen**

Lower concentration of urea in blood, milk and urine with SF

→ **Potential to reduce metabolic load**

Less N excretion in urine and numerically higher N excretion in faeces with SF

→ **Additional protein in the duodenum cannot be used**

→ **Assumed lower environmental load**

Lower number of *Prevotella spp.* and *Ruminococcus flavefaciens,* by trend, and lower VFA level with SF

→ **Decreased protein and carbohydrate degradation**

Acknowledgement

EU Marie Curie Initial Training Network (‘LegumePlus’; PITN-GA-2011-289377)

Annex I: Ingredients and chemical composition of the diets (mean±SD)

	S	BT	L
Ingredients [g/kgDM]			
Hay	408 ± 47.5	391 ± 48.1	417 ± 51.7
Corn silage	224 ± 26.1	215 ± 26.5	229 ± 28.4
Pellets	159 ± 15.4	164 ± 6.68	164 ± 17.5
linseed	47.6 ± 5.54	45.6 ± 5.62	48.6 ± 6.03
Cereal mix	122 ± 64.4	143 ± 62.6	108 ± 63.8
Protein concentrate	37.5 ± 22.7	39.3 ± 18.4	31.8 ± 20.7
Analyzed composition [per kgDM]			
DM	773 ± 2.65	774 ± 3.07	781 ±18.4
OM	932 ± 0.08	929 ± 0.46	928 ± 0.60
CP	139 ± 0.59	149 ± 0.33	142 ± 0.54
NDF	415 ± 4.26	410 ± 5.72	428 ± 7.66
ADF	236 ± 3.13	230 ± 2.15	241 ± 3.29

Annex II: Milk fatty acid composition (g/100g fat)

	S	BT	L	SEM	P-value
C16	23.9	24.8	24.1	1.04	0.66
C18	11.8	10.8	10.9	0.71	0.44
C18:1 c9	16.8[a]	15.7[b]	16.0[ab]	0.04	0.58
C18:2 c9c12	1.59	1.53	1.55	0.09	0.83
C18:2 c9t11 (mg/g)	4.58	4.65	4.68	0.34	0.97
C18:3 c9c12c15	1.07	0.95	0.95	0.05	0.21
∑ C18:1	21.6[a]	20.1[b]	20.8[ab]	0.63	0.03
∑ C18:2	3.15	3.02	3.16	0.14	0.53
∑ C18:3	1.04	1.05	0.94	0.05	0.28
∑ CLA (mg/g)	6.03	6.01	6.19	0.41	0.94

References

Mueller-Harvey, I. 2006. Unravelling the conundrum of tannins in animal nutrition and health. Journal of the Science of Food and Agriculture. 86: 2010-2037