PRIFYSGOL ABERYSTWYTH UNIVERSITY

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Institute of Biological, Environmental and Rural Sciences

Effect of colostrum alternative and milk replacer on lamb performance, health and rumen development

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66th EAAP Annual Meeting
Warsaw (Poland) 3rd Sep 2015

Background

- Sustainable sheep intensification (+prolificacy)
  - Genetic selection
  - Cross-breeding
  - PMSG hormones

- Consequences
  - Insufficient nutrient intake
  - Lamb's deaths (hypothermia, weak immune status, pathologies, low performances)

General alternative

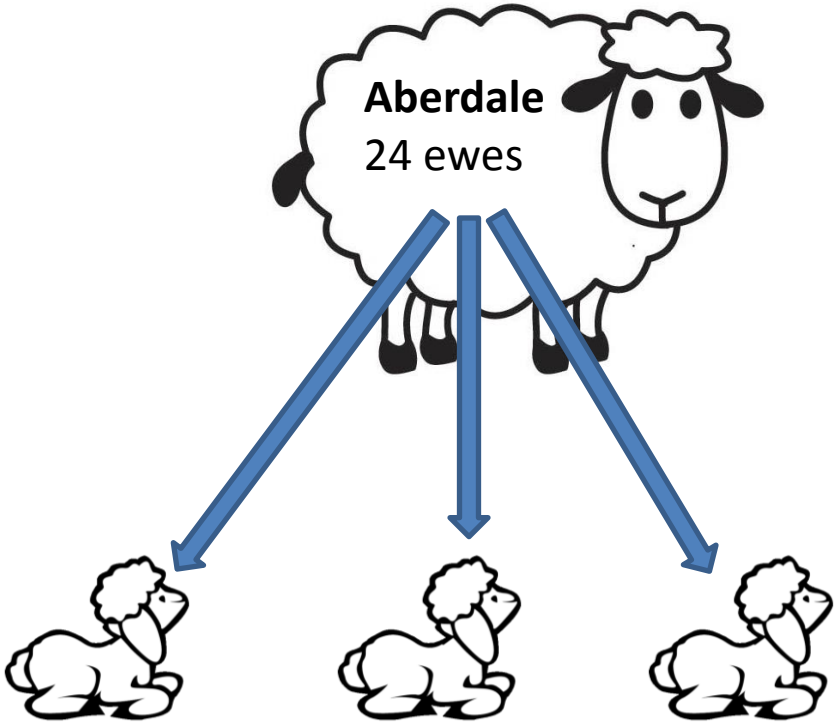
- Artificial colostrum
  - To boost the immune system
- Milk replacer
  - To provide sufficient nutrient intake

- Drawbacks
  - Expensive
  - Negative effects on the rumen development

Objetives

- Asses the effectiveness
- Effects on the rumen development later in life

Experimental design



Treatments	EE	EA	AA
Colostrum	Ewe	Ewe	Ewe+Artificial
Milk	Ewe	Artificial	Artificial

Lamb management

April

At birth

Group AA,Artificial colostrum (50g <6h)

At 24h after birth

Blood sampling for Ig
Distribution in 3 groups

Abrupt weaning (45d)

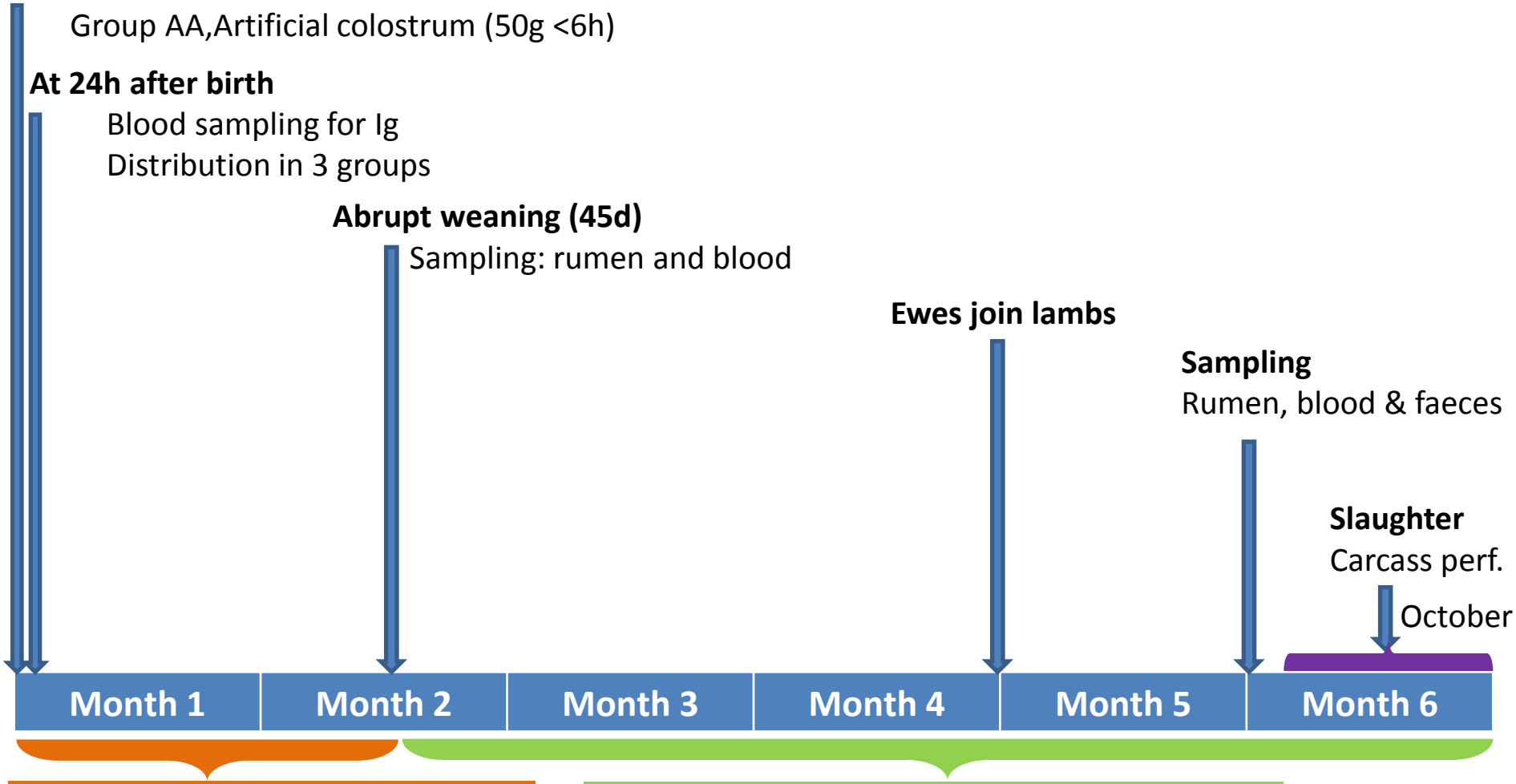
Sampling: rumen and blood

Ewes join lambs

Sampling
Rumen, blood & faeces

Slaughter
Carcass perf.

October



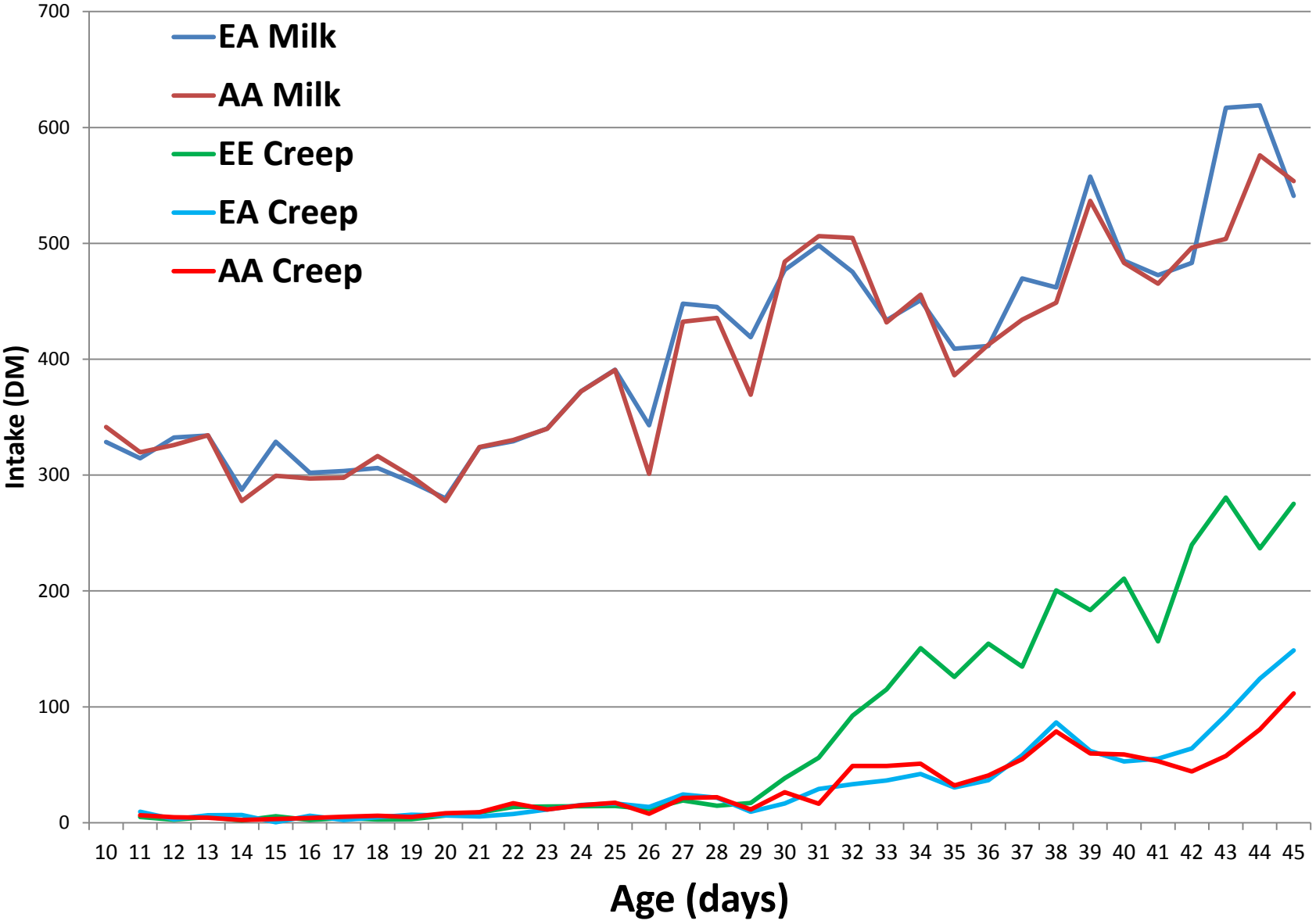
Lactation feeding
Ad-lib milk replacer (except EE)
Ad-lib cheep feed and ryegrass hay
Monitor: health, growth and intake

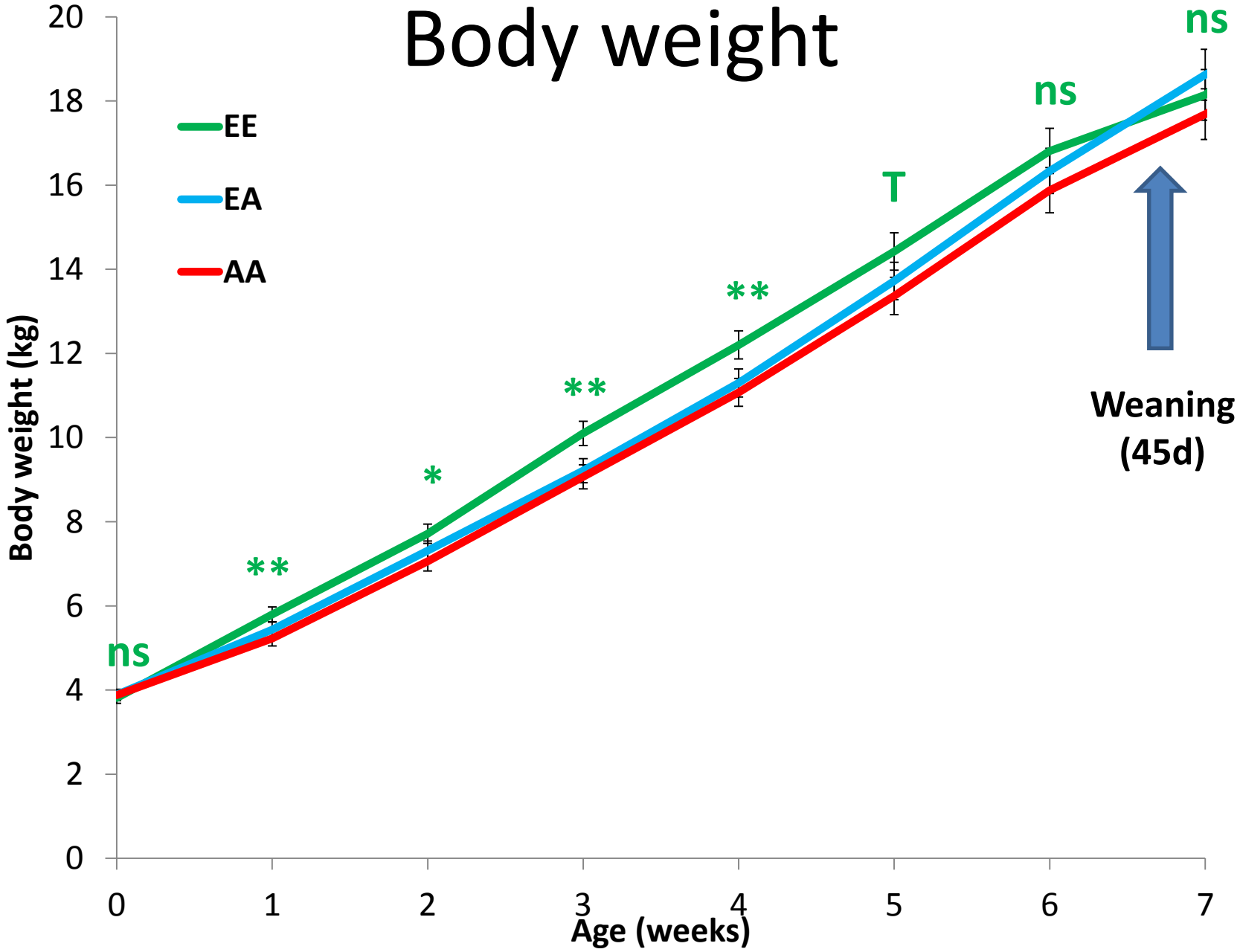
Fattening feeding
All lambs reunited
Ryegrass pasture (creep feed for the first 3 wks)
Monitor: Health and growth

Immune status at 24h after birth

	EE	EA	AA	SED	P-value
Serum Ig G (g/L)					
ELISA	40.9	45.6	37.1	4.19	ns
Reflectometry	38.3	37.0	32.5	0.42	ns

Intakes


EA Milk
AA Milk
EE Creep
EA Creep
AA Creep
Intake (DM)
0
100
200
300
400
500
600
700
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
Age (days)


Body weight
EE
EA
AA
Body weight (kg)
Age (weeks)
0
2
4
6
8
10
12
14
16
18
20
0
1
2
3
4
5
6
7
ns
**
*
**
**
T
ns
ns
Weaning
(45d)

Health during lactation

	EE	EA	AA	SED	P-value
Orf (% of lambs)	0	**83**	**83**		
Diarrhoea (1-5)					
Week 2	1.13^{b}	**1.83^{a}**	**2.04^{a}**	0.229	***
Week 3	1.29^{b}	**1.96^{a}**	**2.33^{a}**	0.269	***
Week 4	1.08^{b}	**1.96^{a}**	**1.92^{a}**	0.252	***
Week 5	1.04^{b}	**1.58^{a}**	**1.96^{a}**	0.227	***
Week 6	1.04	1.08	1.25	0.121	ns
Week 7	1.04	1.04	1.17	0.108	ns
Deaths	0	0	1		

Plasmatic metabolites at weaning

	EE	EA	AA	SED	P-value
Calcium (mM)	2.37^{b}	**2.52^{a}**	**2.48^{a}**	0.03	***
Lipids (mM)					
Cholesterol	2.82	2.91	2.80	0.20	ns
Triglycerides	0.78	0.72	0.75	0.07	ns
HDL	**1.91^{a}**	1.65^{b}	1.67^{b}	0.12	T
LDL	0.76^{b}	**1.11^{a}**	**0.98^{a}**	0.11	**
Proteins (g/L)					
Total proteins	45.4	46.7	46.3	0.79	ns
Albumin	32.9	33.5	33.3	0.42	ns
Globulin	12.5	13.3	13.0	0.75	ns
Creatinine (µM)	83.0	85.8	87.9	4.38	ns
Urea (mM)	3.85	3.95	3.82	0.24	ns
Ammonia (µM)	83.6	81.9	85.2	7.08	ns
Energy					
Glucose (mM)	5.47	5.89	5.75	0.33	ns
Amylase (U/L)	**25.7^{a}**	20.3^{b}	18.4^{b}	1.92	**
β-hydroxybutyrate	**0.27^{a}**	0.10^{b}	0.10^{b}	0.02	***
Enzymes					
L-lactate DH (U/L)	1171	1238	1112	55.5	T
Alk. Phosphatase (U/L)	637^{b}	**841^{a}**	**819^{a}**	56.7	**

Rumen fermentation at weaning

	EE	EA	AA	SED	P-value
pH	6.32^{b}	6.29^{b}	**6.49^{a}**	0.07	*
mg NH_3-N/dL	4.88^{b}	**6.84^{a}**	**5.96^{ab}**	0.70	*
Total VFA, mM	**94.8^{a}**	76.2^{b}	57.7^{c}	8.24	***
Molar proportion					
Acetate	61.0^{b}	**64.9^{a}**	**66.2^{a}**	1.77	*
Propionate	20.3	19.8	18.5	1.66	ns
Butyrate	**13.06^{a}**	8.78^{b}	8.40^{b}	0.87	***
Lactate, mM					
Total	16.6	13.3	15.1	2.02	ns
D-lactate	13.5	10.5	12.3	1.87	ns
L-lactate	3.19	2.83	2.84	0.28	ns

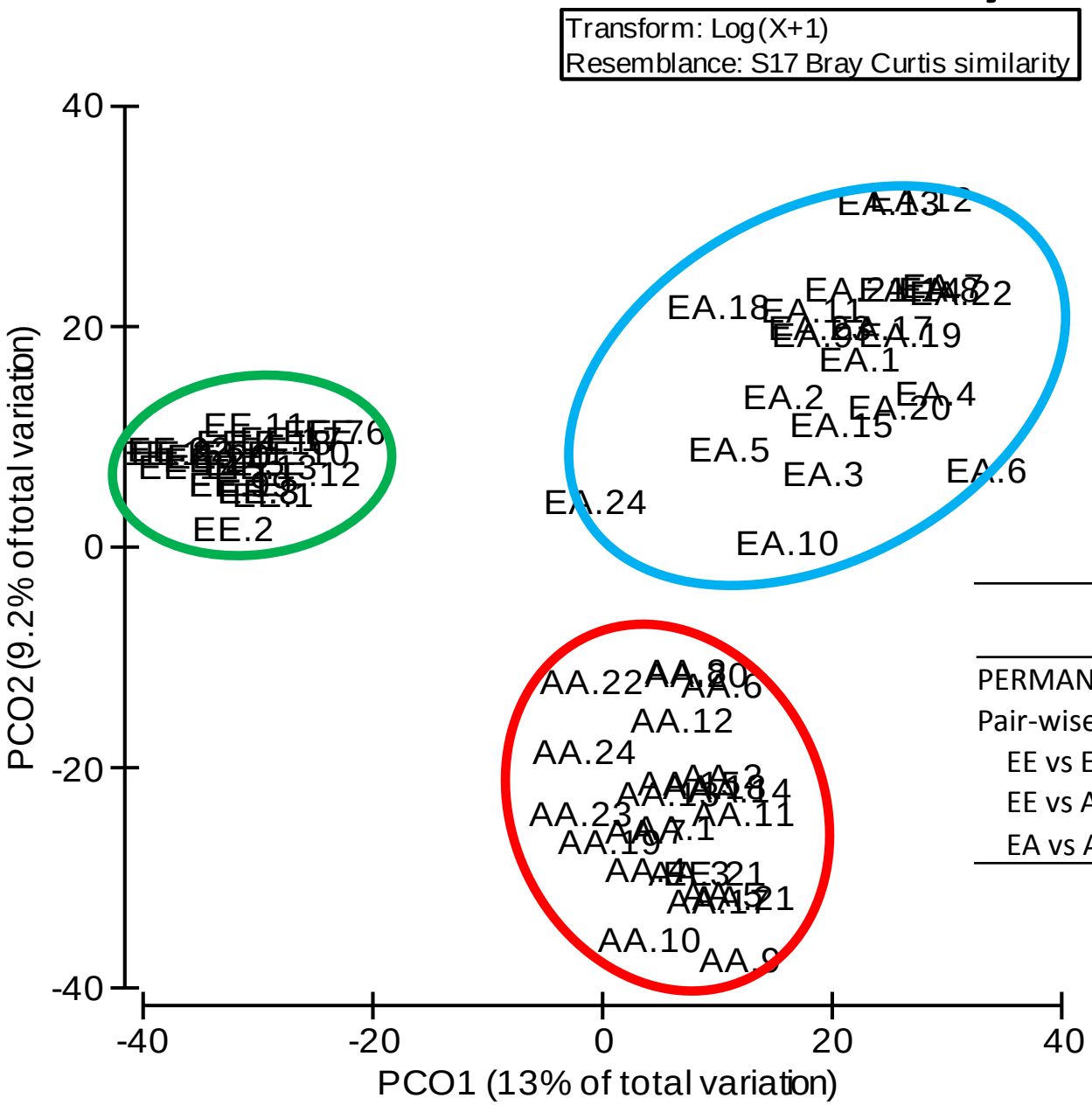
Rumen microbes at weaning

	EE	EA	AA	SED	P-value
Optical quantification					
Total protozoa (10^6 cells/ml)	**1.28**	ND	ND		
% Entodiniinae	**94.2**	ND	ND		
% Diplodiniinae	**3.5**	ND	ND		
% Epidinium	**1.7**	ND	ND		
% Holotrich	**0.6**	ND	ND		
qPCR (log copies/mg DM)					
Protozoa	**8.72**	ND	ND	0.555	***
Bacteria	8.93	**8.97**	**9.05**	0.052	T
Methanogens	6.31	6.34	6.66	0.232	ns
mcrA	3.33	3.31	3.47	0.227	ns
Anaerobic Fungi	5.26	5.36	5.38	0.249	ns

Bacterial biodiversity at weaning

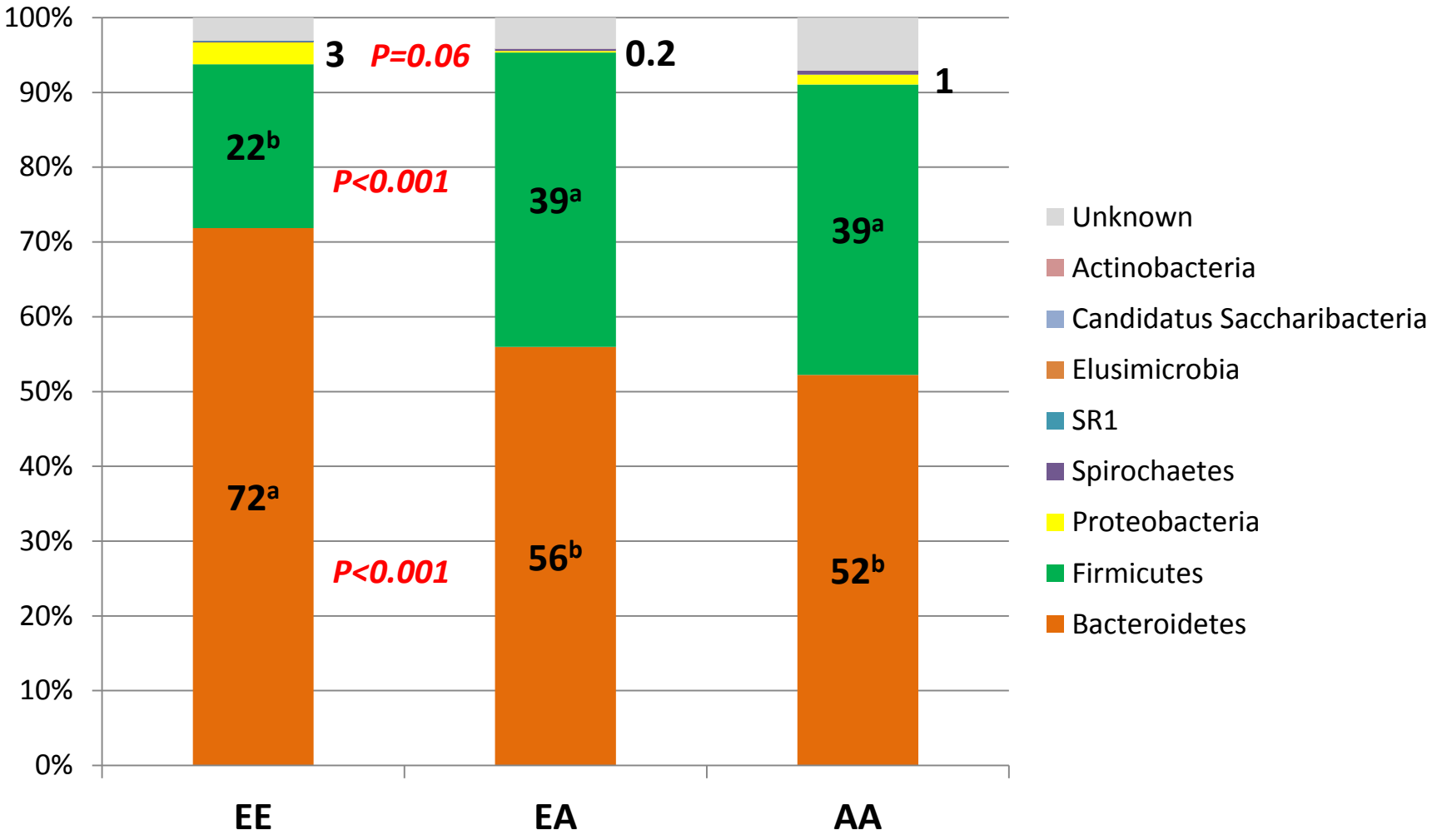
	EE	EA	AA	SED	P-value
Richness (OTUs)	**201^{a}**	114^{b}	120^{b}	10.93	***
Chao index	**334^{a}**	170^{b}	193^{b}	21.54	***
Shannon	**3.86^{a}**	3.28^{b}	3.30^{b}	0.13	***
Evenness	**0.73^{a}**	0.70^{ab}	0.69^{b}	0.02	*
Simpson	0.93	0.92	0.91	0.01	ns

Bacterial community at weaning

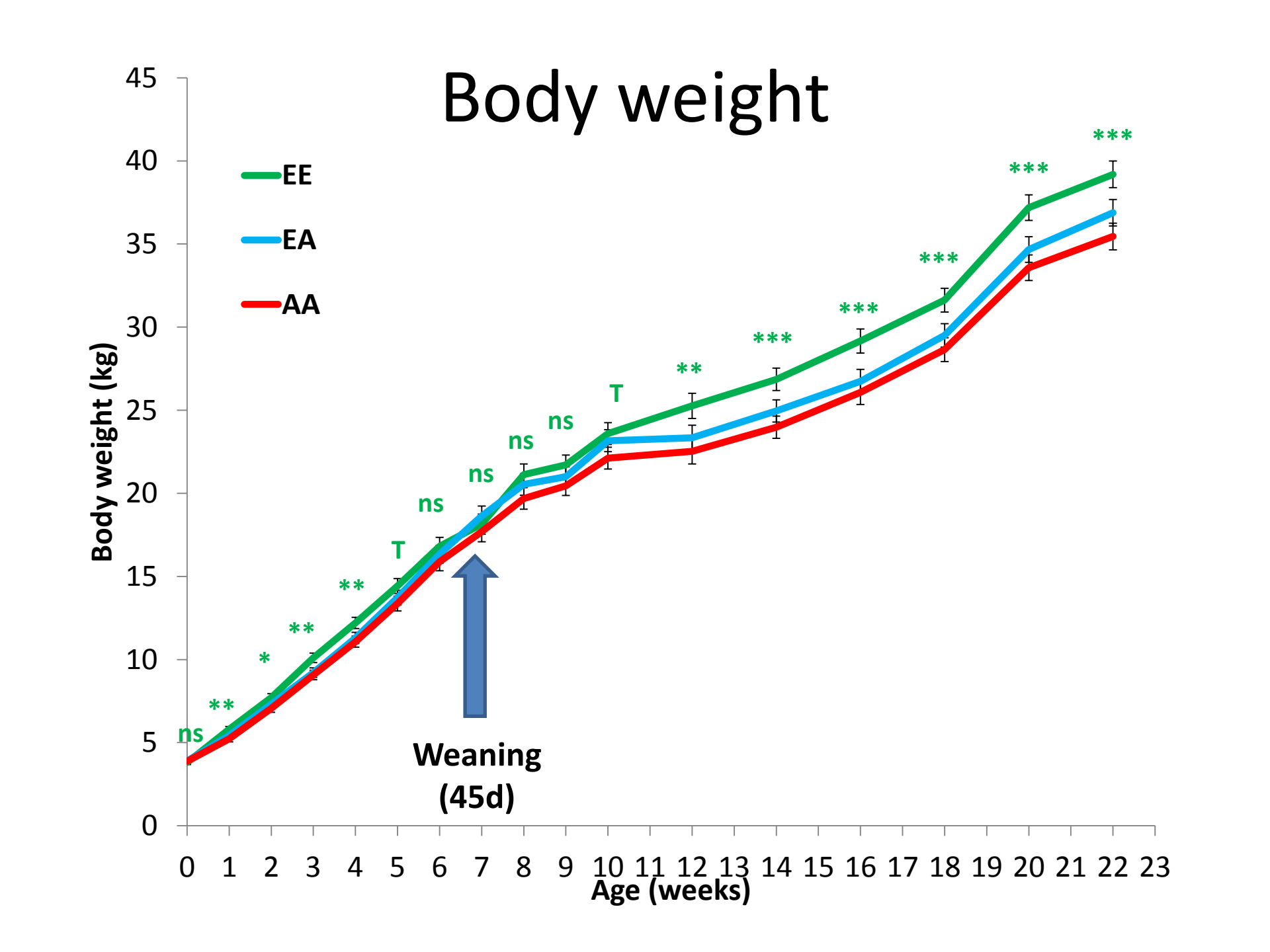


	Similarity	Pseudo-F	P-value
PERMANOVA		8.46	***
Pair-wise			
EE vs EA	4.82	3.10	***
EE vs AA	5.56	2.76	***
EA vs AA	12.71	2.85	***

Bacterial phyla at weaning



4 months later


Body weight
EE
EA
AA
Body weight (kg)
Age (weeks)
Weaning
(45d)
ns
**
*
**
**
T
ns
ns
ns
T
**
***
***
***
***
0
5
10
15
20
25
30
35
40
45
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Plasmatic metabolites at fattening

	EE	EA	AA	SED	P-value
Calcium (mM)	1.80	1.83	2.00	0.13	ns
Lipids (mM)					
Cholesterol	1.29	1.30	1.23	0.08	ns
Triglycerides	0.24	0.22	0.23	0.01	ns
HDL	0.63	0.62	0.61	0.04	ns
LDL	0.61	0.63	0.57	0.05	ns
Proteins (g/L)					
Total proteins	66.1	66.7	66.6	3.55	ns
Albumin	30.6	31.5	30.9	1.39	ns
Globulin	35.6	35.1	35.7	2.40	ns
Creatinine (µM)	79.2	79.5	79.0	2.66	ns
Urea (mM)	10.1	9.91	10.2	0.43	ns
Ammonia (µM)	85.2^{b}	85.3^{b}	**90.9**^{a}	2.25	*
Energy					
Glucose (mM)	3.52	3.63	3.53	0.12	ns
Amylase (U/L)	12.7	10.3	12.8	1.29	T
β-hydroxybutyrate	0.34	0.36	0.40	0.04	ns
Enzymes					
L-lactate DH (U/L)	1172	1105	1097	68.80	ns
Alk. Phosphatase (U/L)	177	191	179	17.03	ns

Rumen fermentation at fattening

	EE	EA	AA	SED	P-value
pH	7.03	7.06	7.02	0.052	ns
mg NH_3-N/dL	7.86	7.48	7.52	0.485	ns
Total VFA, mM	43.5	39.8	39.9	2.268	ns
Molar proportion					
Acetate	59.2	59.8	60.1	0.617	ns
Propionate	20.8	20.4	20.2	0.460	ns
Butyrate	12.4	12.4	12.1	0.615	ns
Lactate, mM					
Total	**5.02^a**	4.23^b	**5.15^a**	0.363	*
D-lactate	**3.40^a**	2.85^b	**3.49^a**	0.261	*
L-lactate	**1.62^a**	1.38^b	**1.66^a**	0.105	*

Gas and methane production

	EE	EA	AA	SED	P-value
Incubation 24h					
Total gas (mL)	23.7	23.5	24.2	0.968	ns
Methane (%)	12.3	12.2	12.9	0.511	ns
Methane emmisions (mL)	2.84	2.92	3.01	0.173	ns

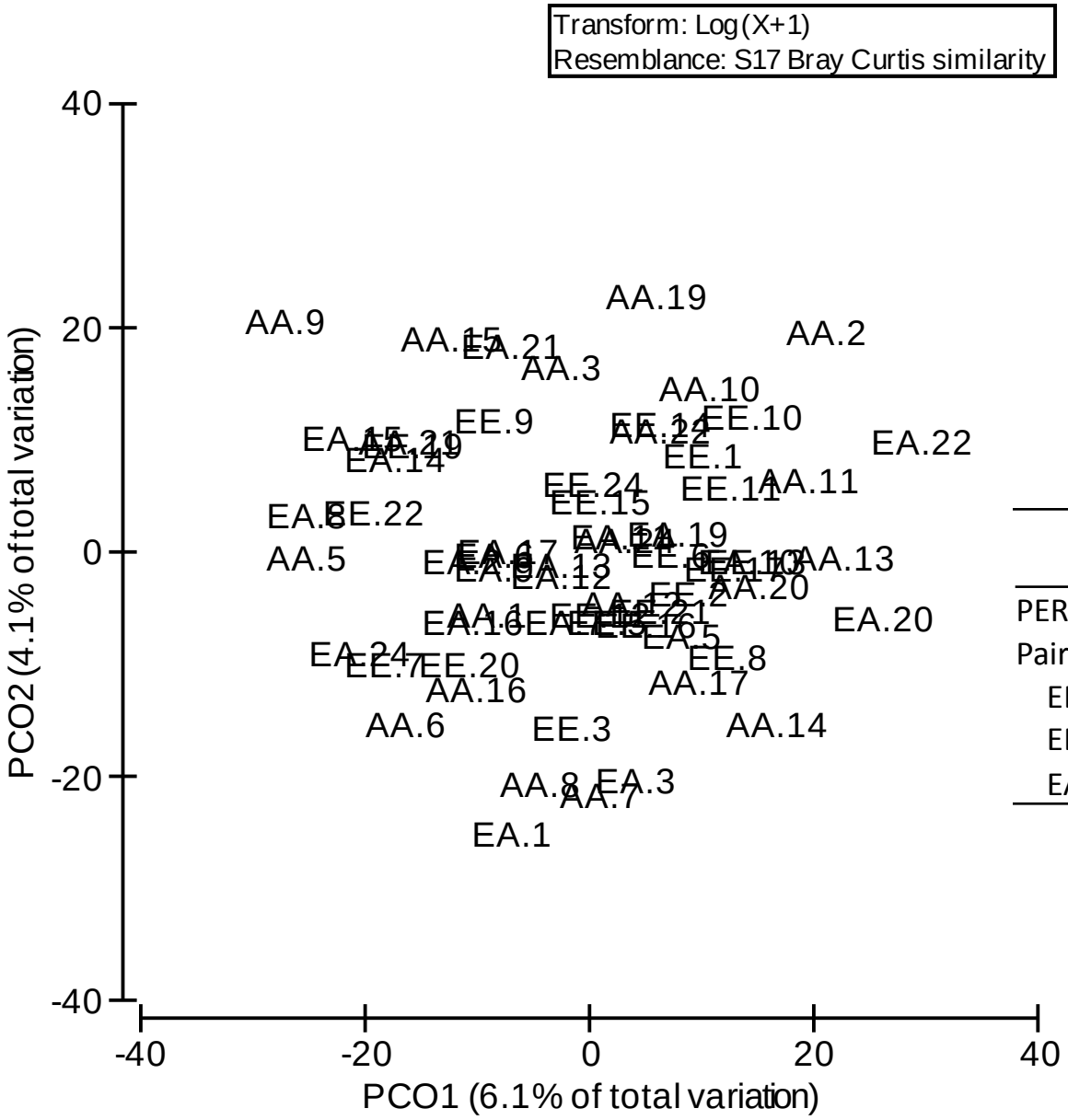
Rumen microbes at fattening

	EE	EA	AA	SED	P-value
Optical quantification					
Total protozoa (10^6 cells/ml)	5.86[a]	**5.71[b]**	5.87[a]	0.059	*
% Entodiniinae	96.4	96.7	93.7	2.077	ns
% Diplodiniinae	2.36	1.58	2.06	1.036	ns
% Epidinium	0.51	0.96	3.27	1.501	ns
% Holotrich	0.19	0.00	0.06	0.125	ns
qPCR (log copies/mg DM)					
Bacteria	8.90[b]	**8.99[a]**	8.91[b]	0.035	*
Methanogens	6.62	6.78	6.65	0.093	ns
mcrA	3.80	3.81	3.80	0.067	ns
Anaerobic Fungi	5.93	6.17	6.01	0.129	ns

Bacterial diversity at fattening

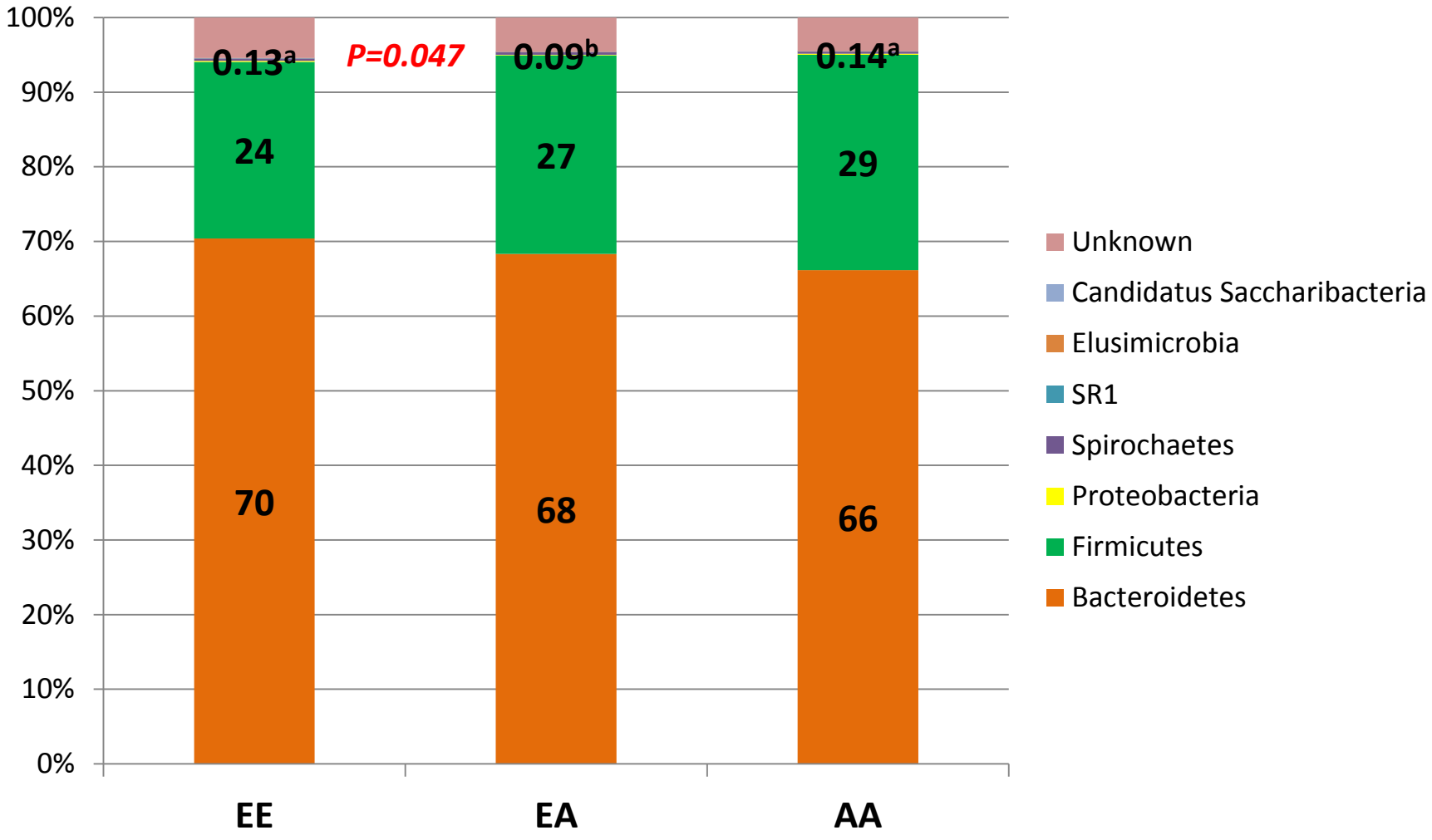
	EE	EA	AA	SED	P-value
Richness (OTU´s)	329	328	330	16.1	ns
Chao index	626	648	631	45.0	ns
Shannon	0.47	0.45	0.46	0.01	ns
Evenness	4.61	4.62	4.64	0.13	ns
Simpson	0.80	0.80	0.80	0.02	ns

Bacterial community at fattening

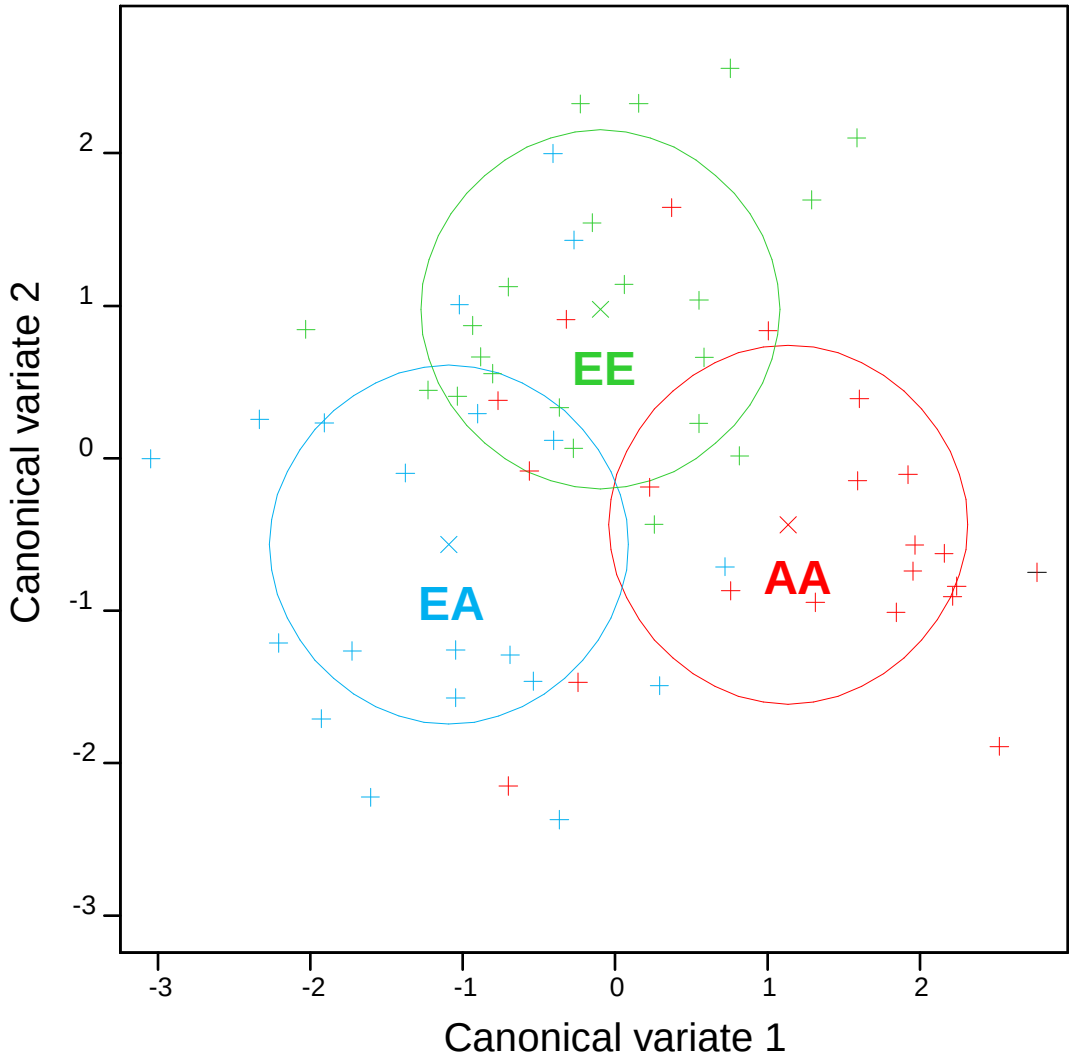


	Similarity	Pseudo-F	P-value
PERMANOVA		1.06	ns
Pair-wise			
EE vs EA	23.9	1.01	ns
EE vs AA	24.2	1.09	ns
EA vs AA	23.5	0.98	ns

Bacteria phyla at fattening



Faecal analysis (FTIR spectroscopy)



Methane and digestibility at fattening

	EE	EA	AA	SED	P-value
Faecal analysis					
Ash / OM	**0.16^{a}**	0.14^{b}	0.15^{ab}	0.004	**
Ash / C	**0.27^{a}**	0.24^{b}	0.26^{a}	0.007	**
Ash / N	**3.93^{a}**	3.54^{b}	3.77^{a}	0.145	*
Ash / NDF	0.19	0.19	0.20	0.007	ns
Ash / ADF	0.35	0.32	0.35	0.016	ns

Carcass performance

	EE	EA	AA	SED	P-value
Carcass weight (kg)	18.3	18.2	17.6	0.51	ns
Conformation (EUROP)	3.81	3.62	3.52	0.17	ns
Fatness	2.74	2.76	2.69	0.17	ns

Conclusions

- Artificial lactation
  - Maximized the number of lambs weaned per ewe
  - Similar weaning weights
  - Similar carcass performance

- But,
  - Tended to suffer more health issues
  - Lower rumen development at weaning (physiological & microbiological)

- Differences in rumen function observed at weaning
  - Tended to disappear during the fattening period
  - But some residual effects could persist and affect animal performance

Acknowledgements

This work has been supported by:

RumenStability