

FAECAL MICROBIOTA TRANSPLANT ALTERS GROWTH AND INTESTINAL BACTERIAL PROFILE OF PIGS

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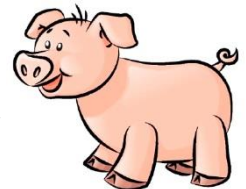
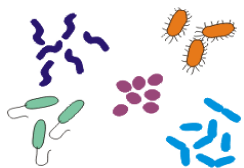
Introduction

- Feed efficiency (FE) is critical in pig production
- Previous work: pigs divergent in FE = different intestinal microbiota profiles (abstract no. 24330 & 24596)
- Manipulation of the microbiota: **Faecal microbiota transplantation (FMT)**
 - Transfer of microbiota to establish a more desirable bacterial profile
 - **Humans** (enema): GIT disease treatment (e.g. *Clostridium difficile*)
 - **Pigs** (oral): human microbiota-associated pig model (Pang *et al.*, 2007; Zhang *et al.*, 2013)

First attempt of using FMT to improve FE

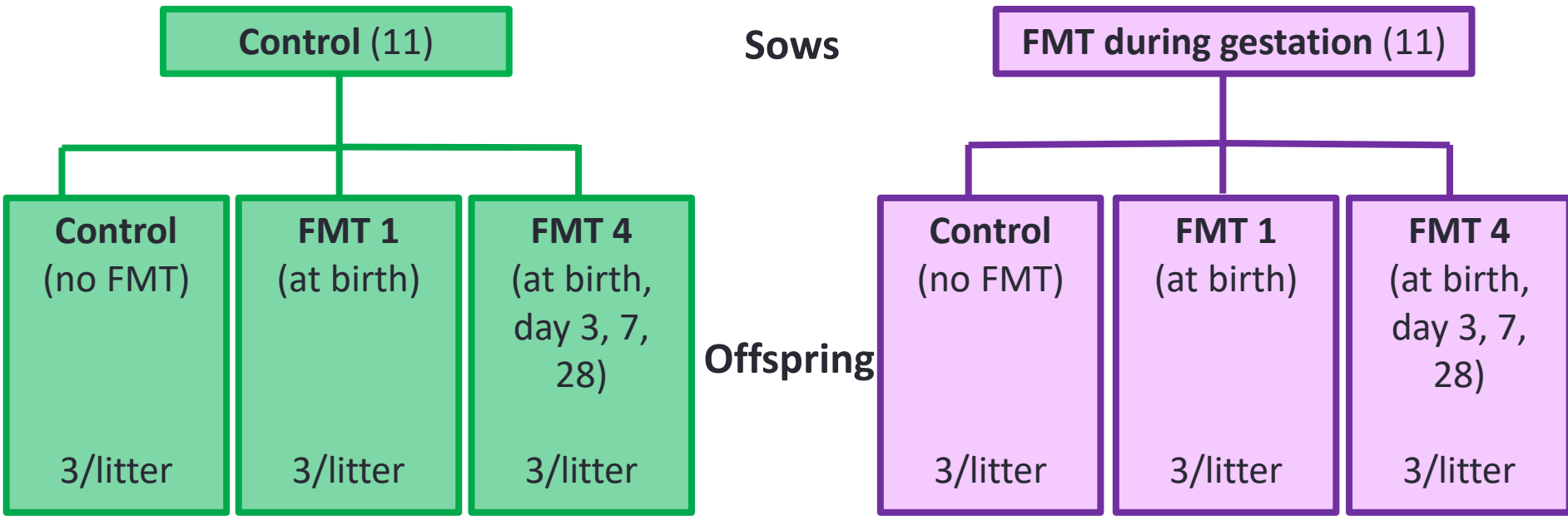
Hypothesis:

Inoculating sows & piglets with faecal extracts from highly feed efficient pigs will result in a “desirable” microbiota for improved FE?



FMT of sows & offspring (2 x 3 factorial design)

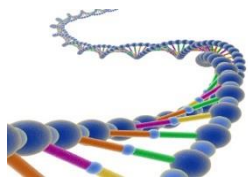
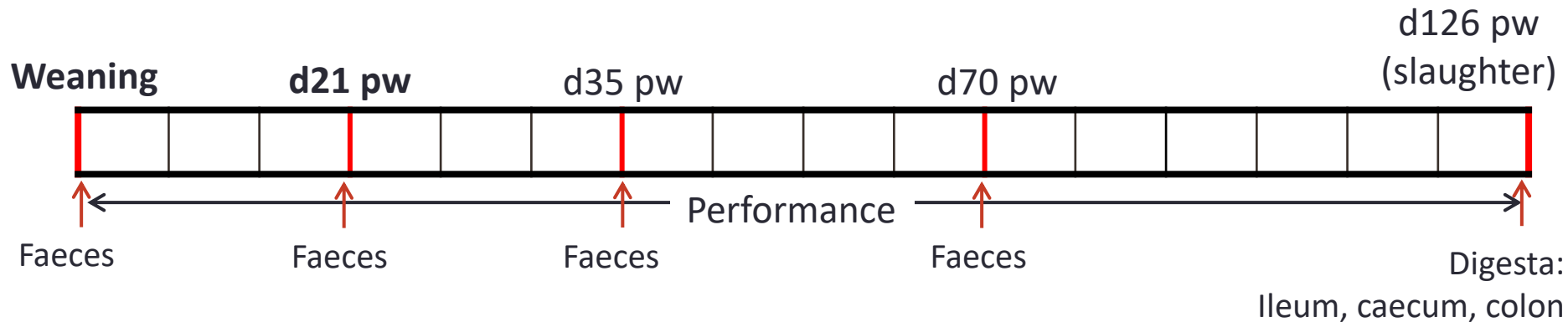
Day 60: 1 wk of antibiotics
Day 68: purgative & 36h fasting
Day 70 & day 100: inoculum + anti-acid



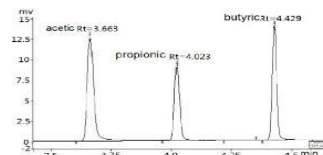
Faecal inoculum
Faeces from 4 finisher pigs screened on RFI (most feed efficient of 409 pigs; abstract no. 24596); anaerobically processed. Samples pooled, diluted, centrifuged & pellets re-pooled, diluted with 20% glycerol, aliquoted & stored at -80°C until use.
Sows: 200ml (2×10^{11} CFU; gastric intubation); piglets: 8ml (9×10^9 CFU; orally).

Offspring study

- **At weaning**
 - 81 piglets (1/gender/trt/litter)
 - Individually housed to slaughter (150 days old)
- **At slaughter**
 - 36 (1/trt/litter) sampled



16S rRNA gene sequencing



Volatile fatty acids



Histology



Biochemistry

Ileal tissue
Blood serum

Results

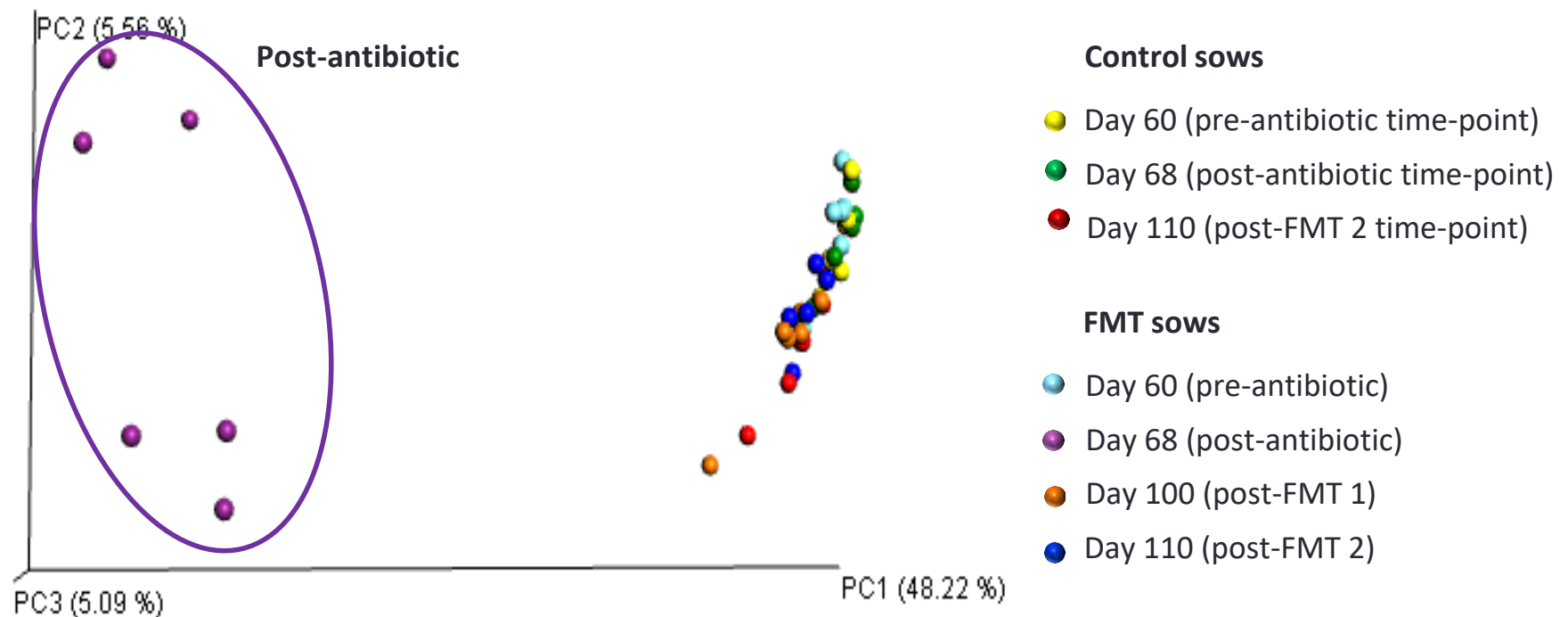
Growth performance

Parameter	Sow trt		S.E.	P
	Control	FMT		
Weaning weight (kg)	7.4	7.2	1.38	0.56
Slaughter weight (kg)	121.7	113.5	1.42	
ADFI (g/day)	1835	1708		
ADG (g/day)	872			
FCE (g/g)	2.04			0.75

Parameter	Pregnancy trt			S.E.	P
	Control	FMT 1	FMT4		
Weaning weight (kg)	7.9	7.5	7.8	1.71	0.98
Slaughter weight (kg)	120.8 ^a	114.5 ^b	116.5 ^b	1.67	0.03
ADFI (g/day)	1830	1712	1785	49.9	0.22
ADG (g/day)	877	825	847	20.0	0.19
FCE (g/g)	2.05	1.98	2.07	0.041	0.27

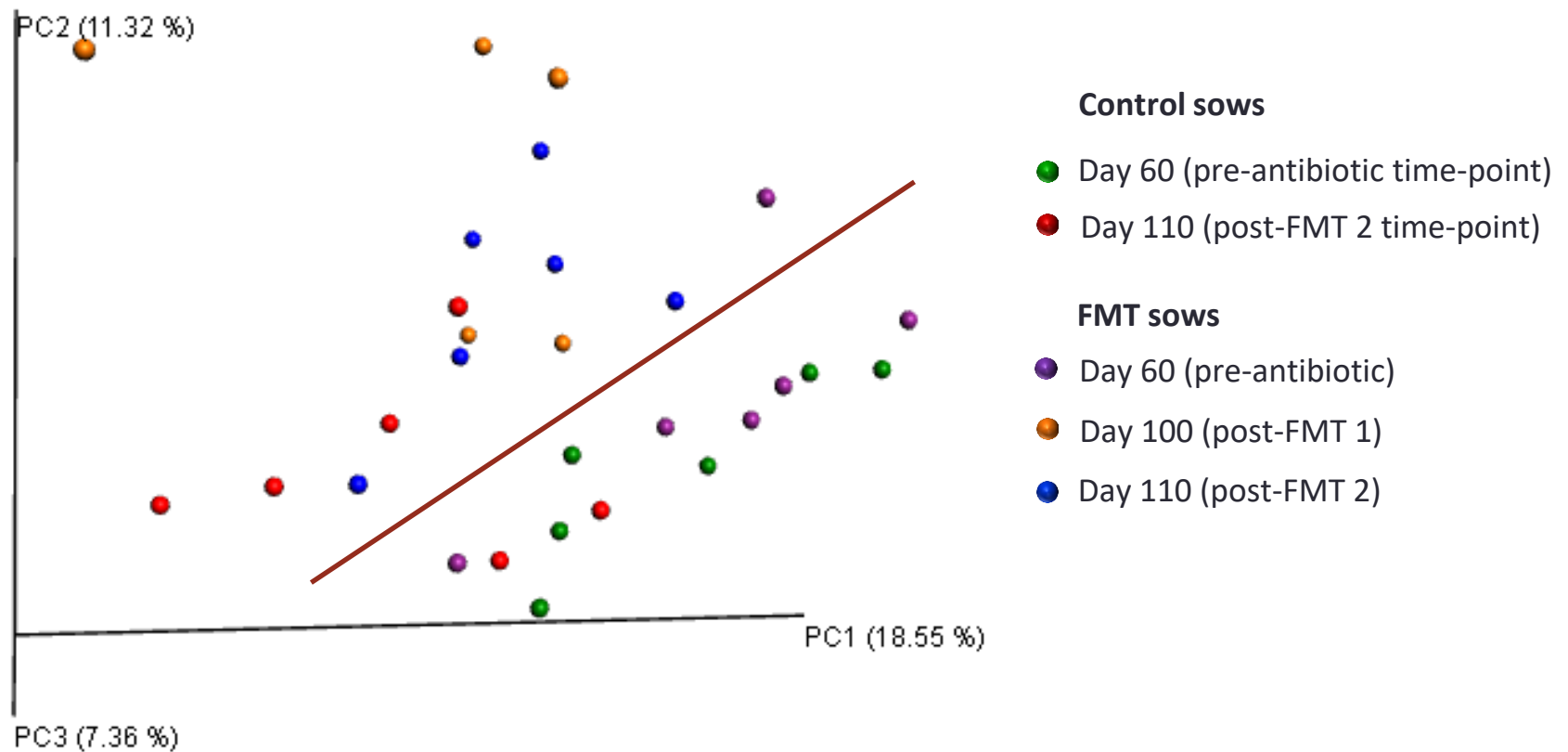
FMT ↓ slaughter weight

β -diversity: Sow faecal microbiota during gestation



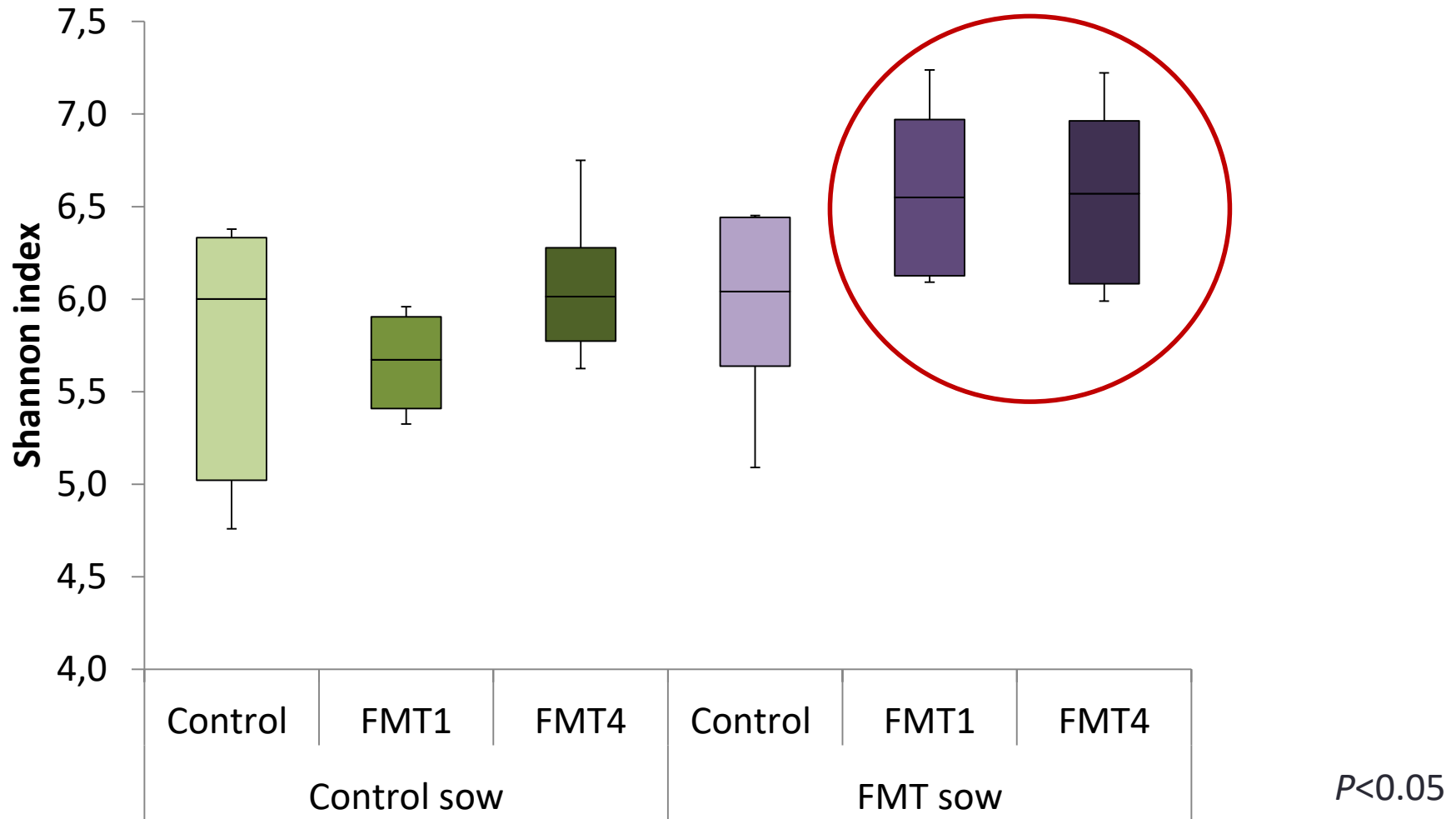
- Antibiotic trt had the greatest influence on microbial diversity
- Microbial diversity recovered following FMT

β -diversity: Sow faecal microbiota during gestation



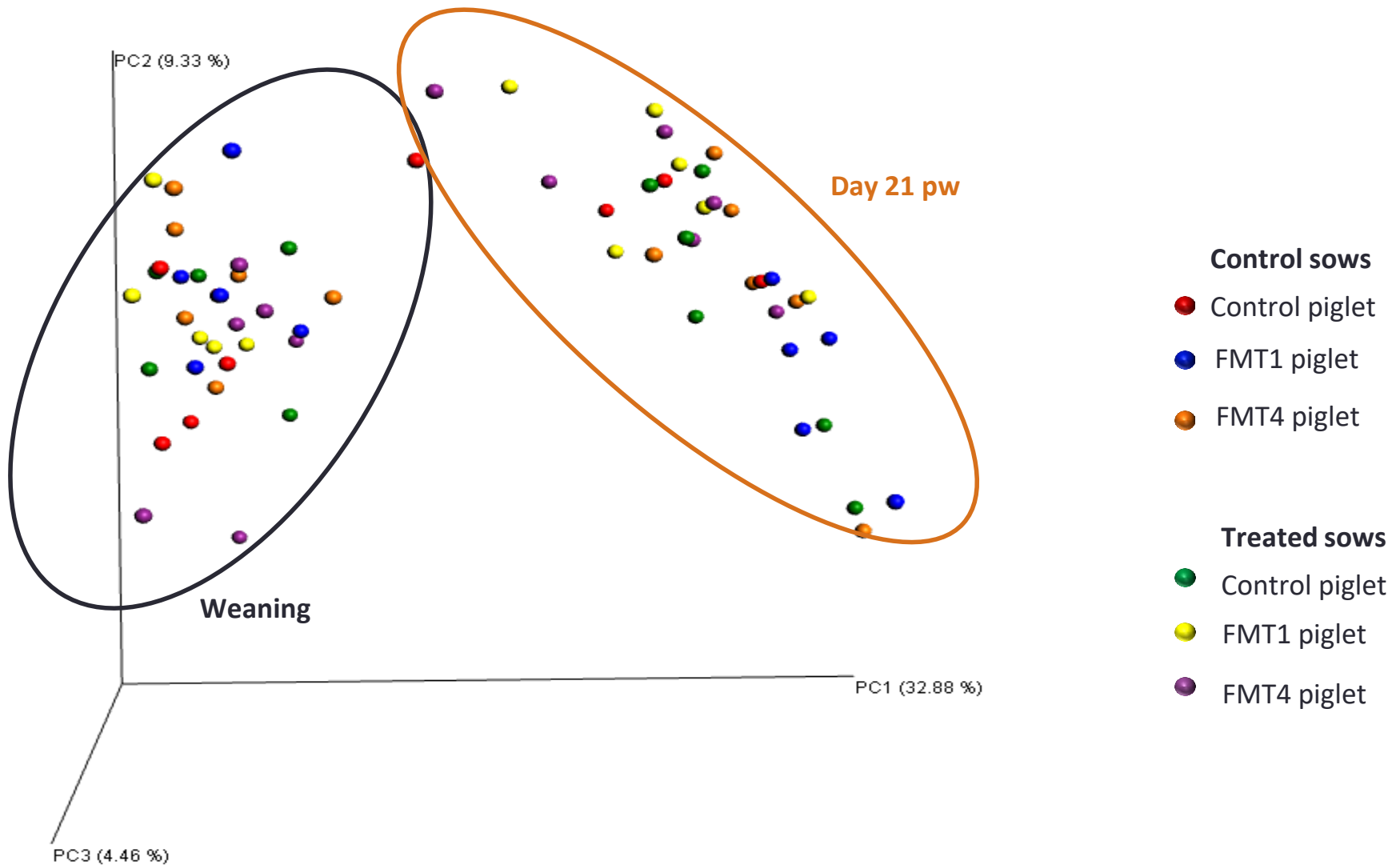
- Pre-FMT samples cluster separately from post-FMT

α -diversity: offspring at day 21 pw (family level)



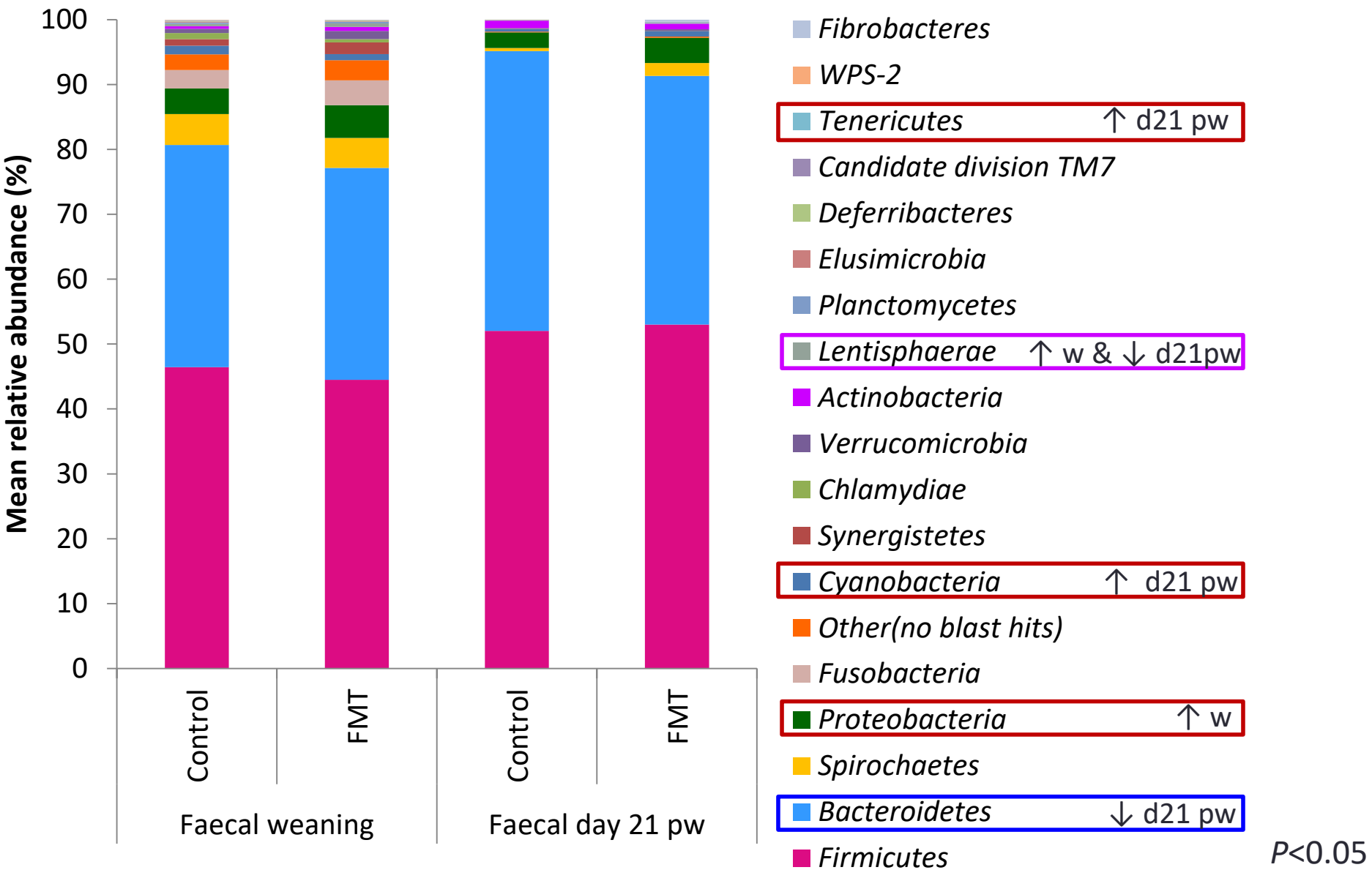
- Piglets receiving FMT (1 or 4 times) from FMT-sows had higher bacterial diversity

β -diversity: Offspring faecal microbiota



- Age of pig having greater effect on microbial diversity than trt

Compositional differences in offspring bacterial phyla

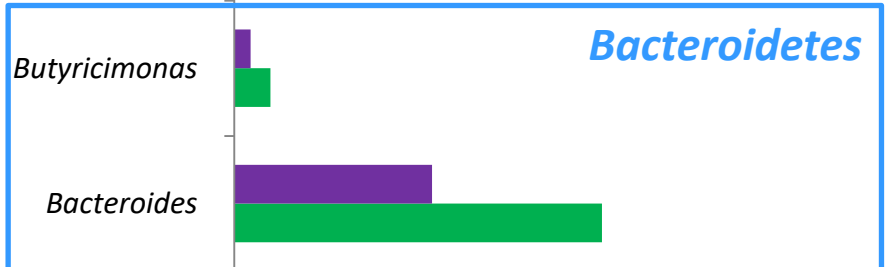
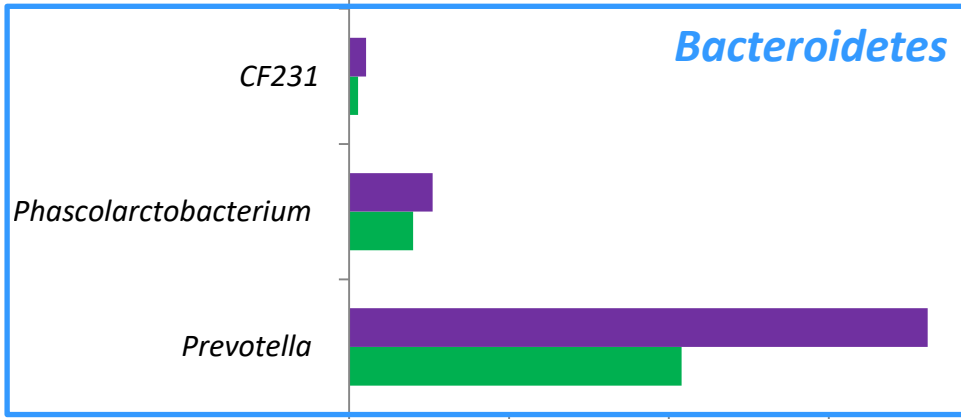
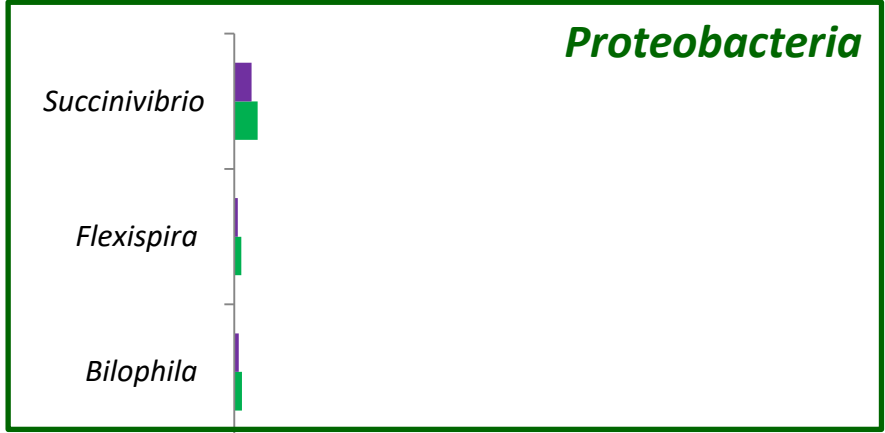


FMT-associated differences in offspring genera at weaning

Control
FMT

Increased

Decreased



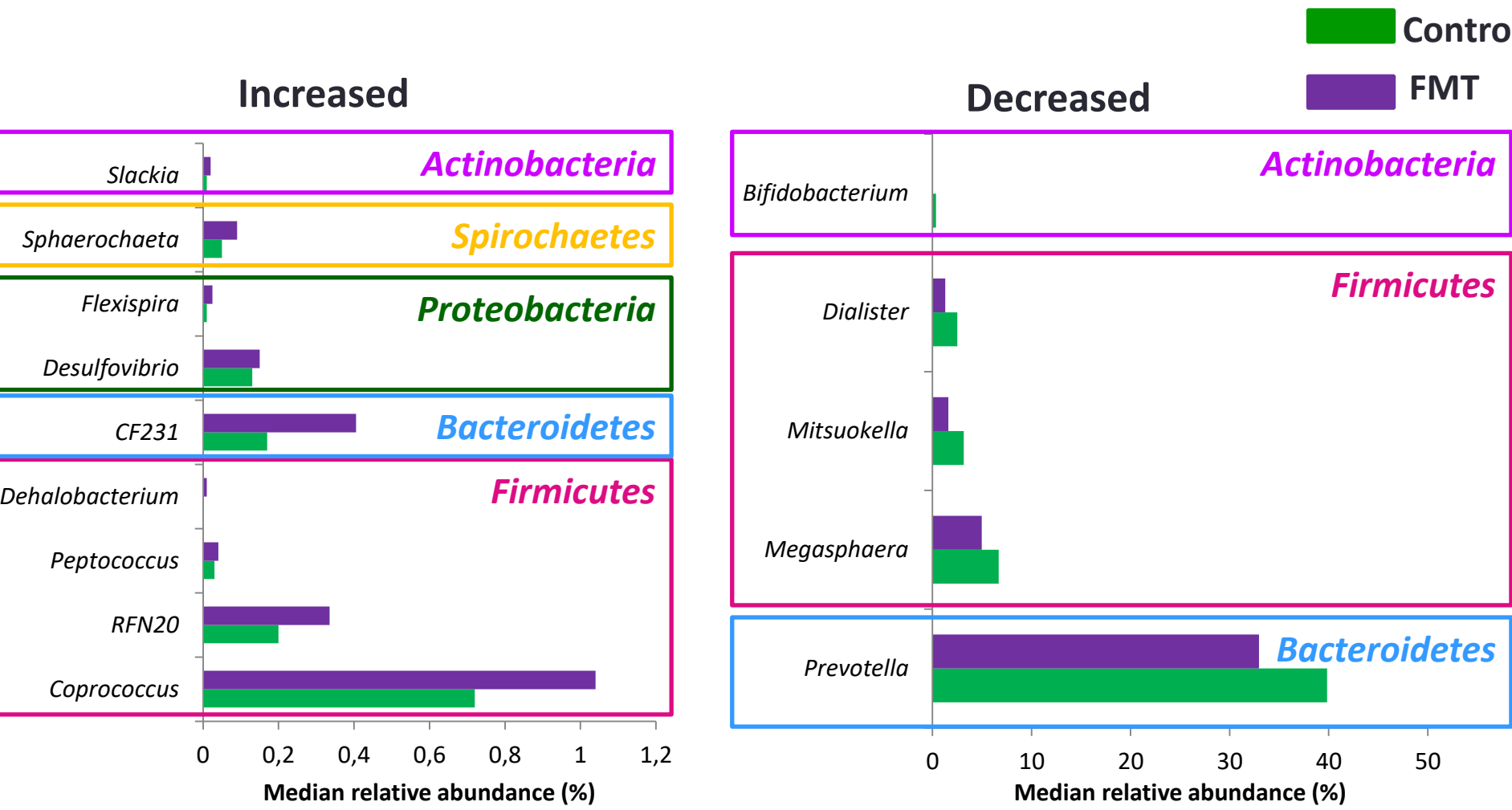
0 5 10 15 20
Median relative abundance (%)

0,0 2,0 4,0 6,0
Median relative abundance (%)

- 10 /131 genera different
- ↑ potential pathogens (CF231); ↓ metabolism & VFA producers

P<0.05

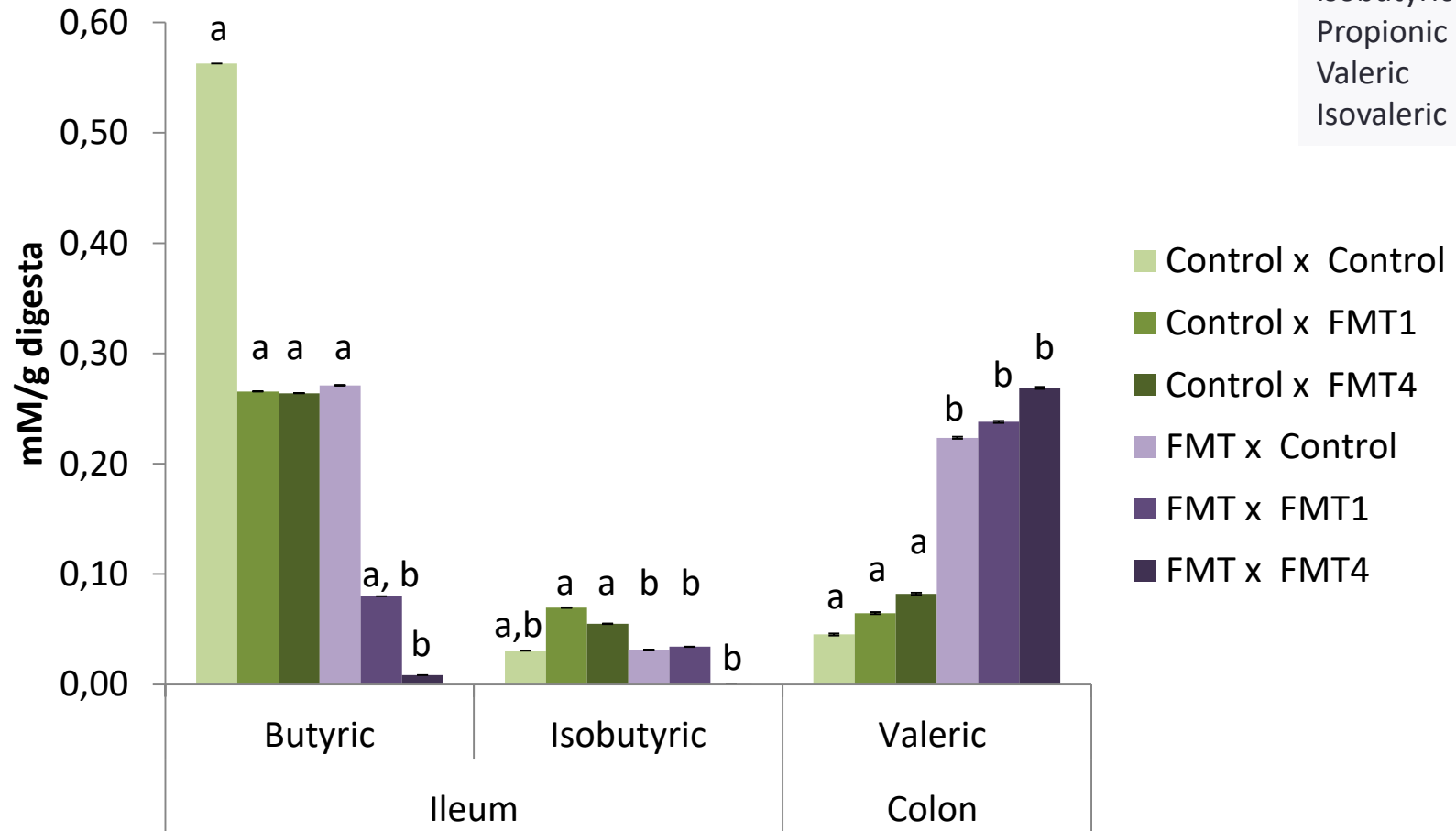
FMT-associated differences in offspring genera at day 21pw



- 14 /131 genera different
- ↓ metabolism & VFA producers
- *Prevotella* & *Mitsuokella* associated with body weight (Mach *et al.*, 2015) P<0.05

Volatiles fatty acid concentrations in digesta

Acids measured:
 Acetic
 Butyric
 Isobutyric
 Propionic
 Valeric
 Isovaleric



- Sow trt: ↓ isobutyric (ileum) & ↑ valeric acid (colon) in pigs from FMT-sows
- Piglet trt: propionic acid ↓ in FMT 4 pigs

P < 0.05

Ileal histology

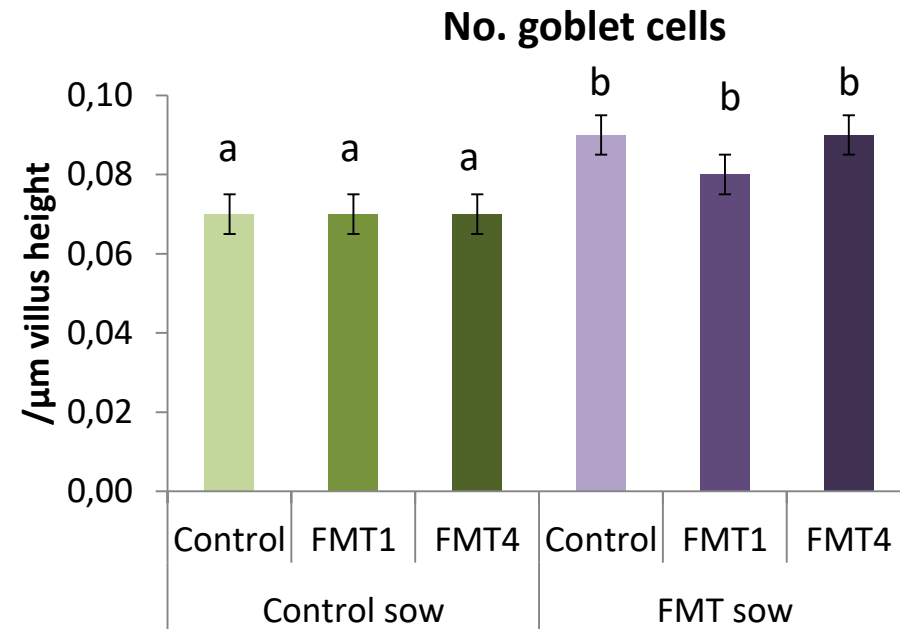
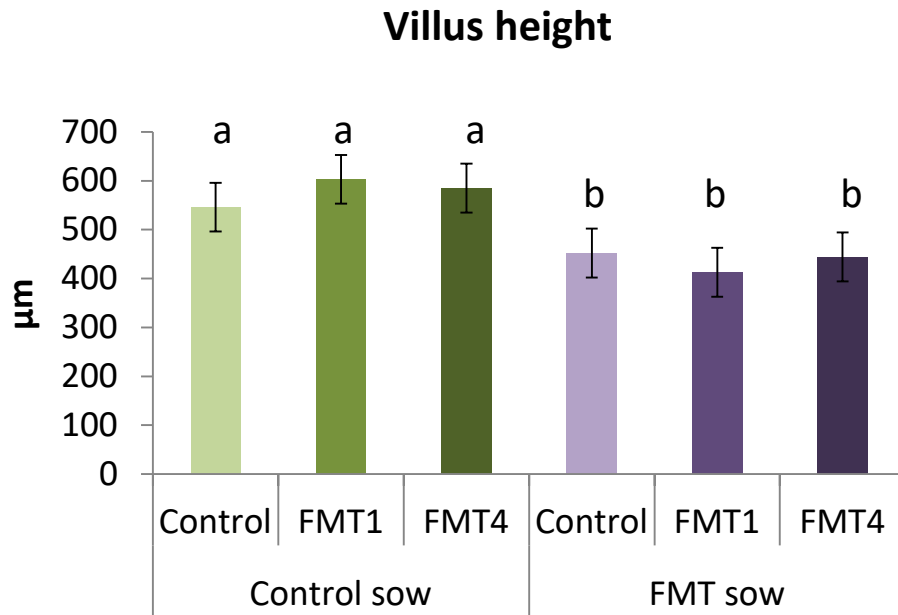
Measured:

Villus height, width, area

Crypt depth

Villus height: crypt depth

No. goblet cells (per villus & per μm villus height)



- In pigs from FMT-sows:
 - \downarrow villus height, width, area & crypt depth
 - \uparrow no. of goblet cells/ μm villus height
- Piglet trt: no differences between control vs. FMT1 vs. FMT4

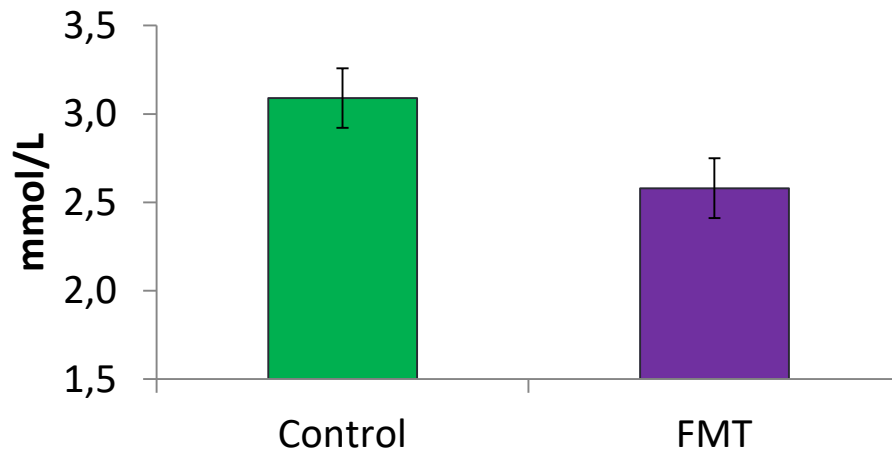
$P < 0.05$

Serum biochemistry

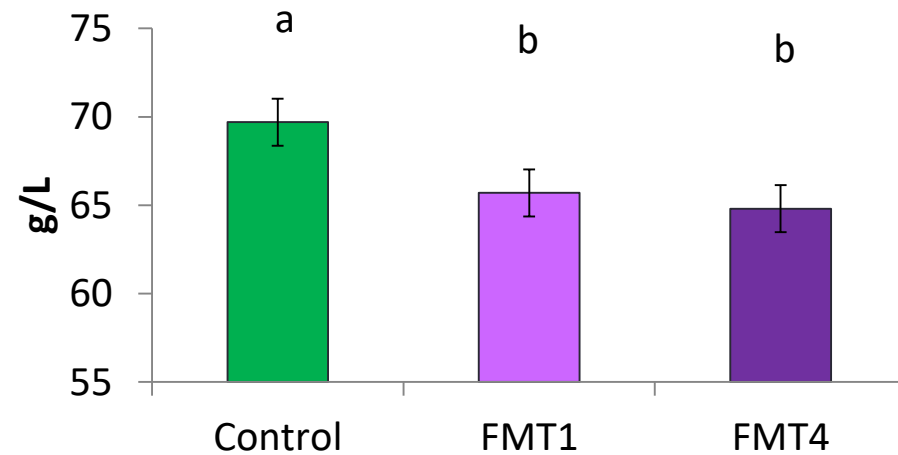
- No significant differences observed for sow x piglet trt

Measured:
Total protein
Blood urea nitrogen
Glucose
Triglycerides
Cholesterol
Creatinine
Creatine kinase

Cholesterol



Total protein



- Sow trt: ↓ cholesterol in pigs from FMT-sows
- Piglet trt: ↓ total protein in pigs from FMT1 & FMT4 trt
- Values within normal range

$P < 0.05$

Conclusions



- **Growth performance**

- ↓ slaughter weight in pigs: 8kg (FMT in sows) & 6kg (FMT in piglets)

Found ≠ Expected

- **Intestinal microbiota** in piglets from FMT-sows

- ↓ beneficial microbes (e.g. butyrate producers, *Bifidobacterium*)
- ↓ *Prevotella* & *Mitsuokella*: associated with body weight gain

Biomarkers for FE?

- **VFA concentrations**

- ↓ beneficial VFAs (butyric & isobutyric acids) in the ileum
- ↑ valeric acid in the colon: ↓ colonic absorption?

- **Ileal histology**

- ↓ villus height ↑ goblet cells: ↓ nutrient absorption?

Early life intestinal microbiota impacts lifetime growth in pigs

Acknowledgements

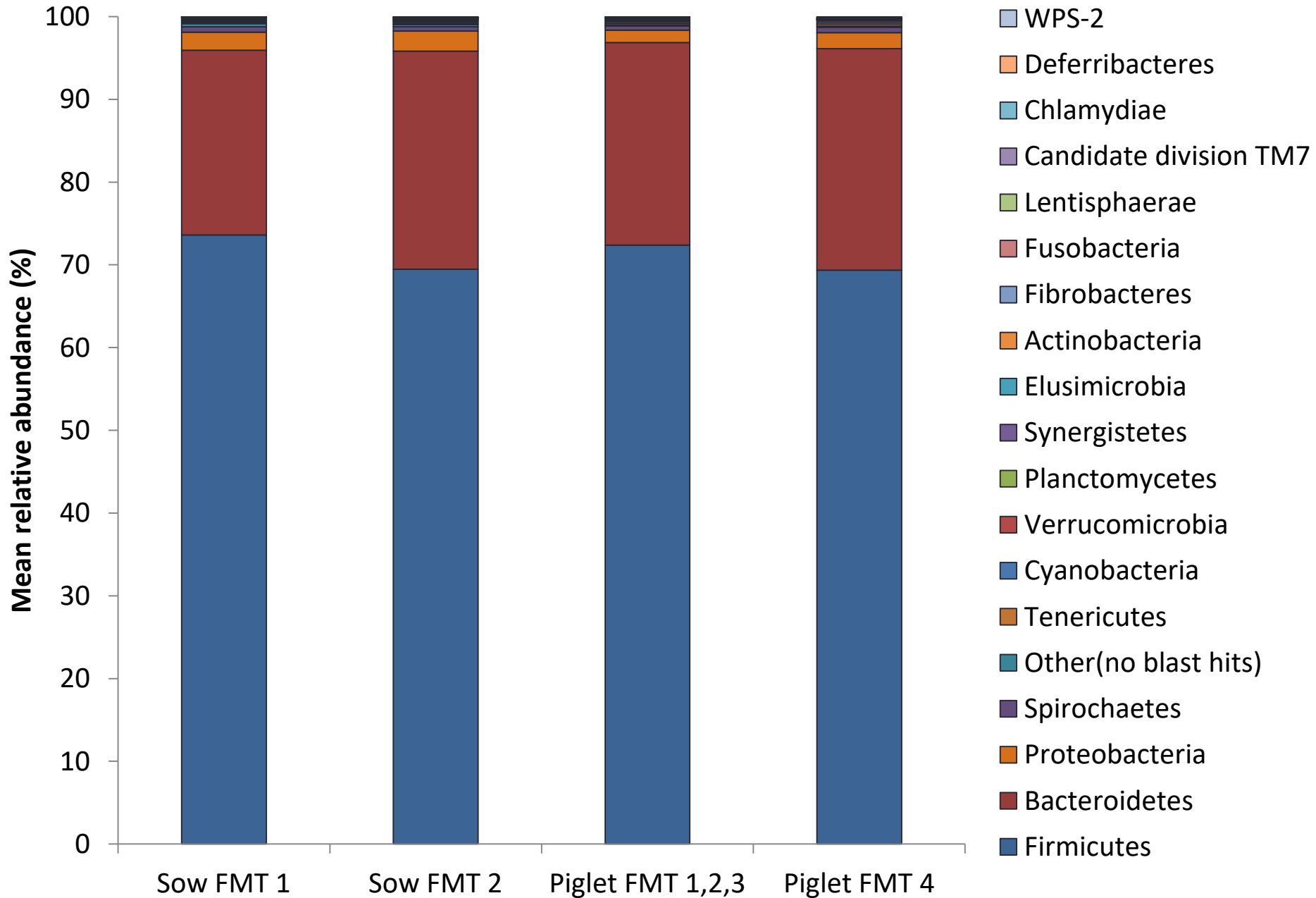


- ECO-FCE project (7th FP-EU) & partners
- Teagasc Walsh fellowship programme
- Co-workers from the Pig Department & Food Centre Teagasc, & WIT

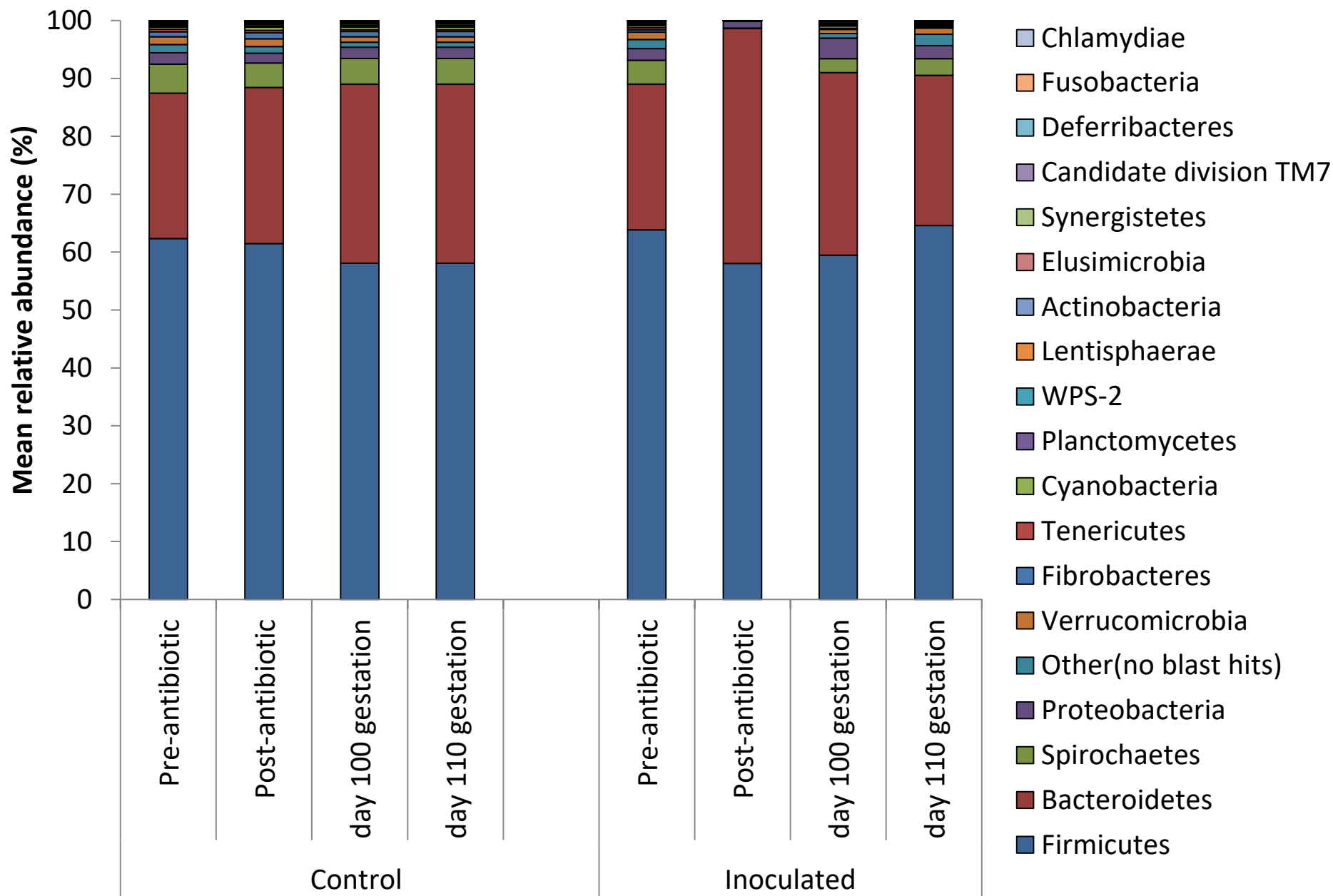
Thank you



Thawed inoculum: phylum level

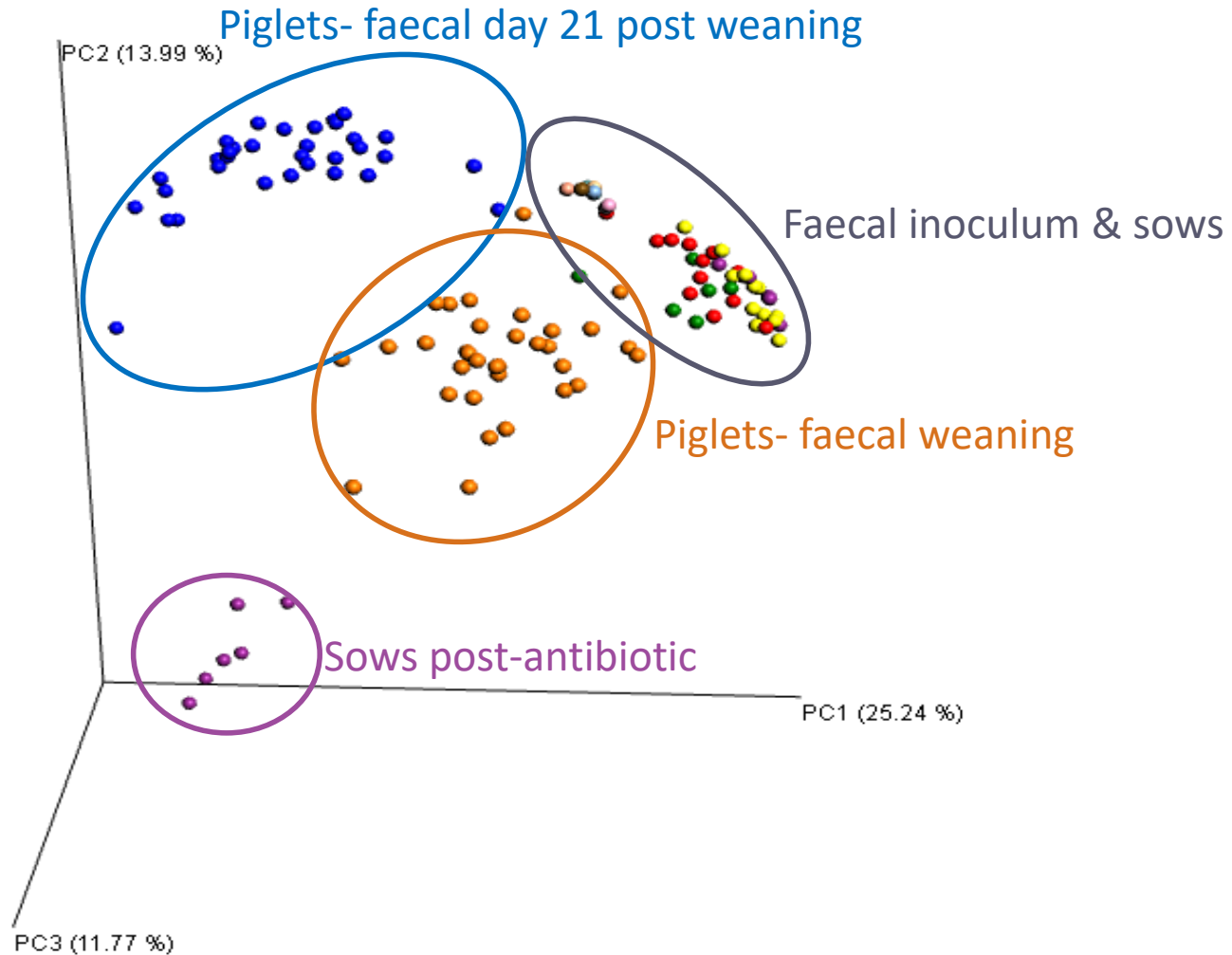


Results: Phylum relative abundance



All together

- PCoA plots



Results: thawed inoculum PCoA plot

