EFFECT OF CARBOHYDRASE USE AND SOAKING OF CEREALS ON THE GROWTH OF LIQUID-FED FINISHER PIGS

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67th Annual Meeting of the European Federation of Animal Science
Belfast UK, 29th Aug – 2nd Sept 2016

Introduction

LIQUID FEEDING:

Processing effect on feed?

- Activation of endogenous/exogenous enzymes
- Pre-degradation of NSP present in the diet
- Proliferation of good/bad bacteria

Introduction

Hypothesis:

- Liquid feeding and soaking will ↑ nutrient digestibility compared to dry diets
- Pig growth and feed efficiency (FE) will be improved by enzymes supplementation

Objective:

To assess the efficacy of liquid feeding, pre-soaking (full diets /cereal fraction) and enzymes supplementation on pig FE and nutrient digestibility

Material and Methods

Experiment 1 (IRTA, Spain):

5 Experimental diets

DRY *vs.* **FRESH LIQUID** vs. **SOAKED LIQUID** (Full diet, 8h)

ENZYME *vs.* **NON-ENZYME** supplementation

Enzymes: Xylanase + ^{2} -glucanase (Safizym XP20, Safizym GP40; Lesaffre)

Experiment 2 (Teagasc, Ireland):

4 Experimental diets

FRESH LIQUID *vs.* **SOAKED LIQUID** (Only cereals, 3h)

ENZYME *vs.* **NON-ENZYME** supplementation

Enzymes: Xylanase + ^{2} -glucanase (Excel AP, Adisseo)

EXPERIMENT 1

EXP. 1: Material and Methods

Enzymes: Xylanase + ² -glucanase

180 B@(LWxLD)xPi
Exp. unit: pen of 4 pigs
n= 9
20 ~ 105 kg LW

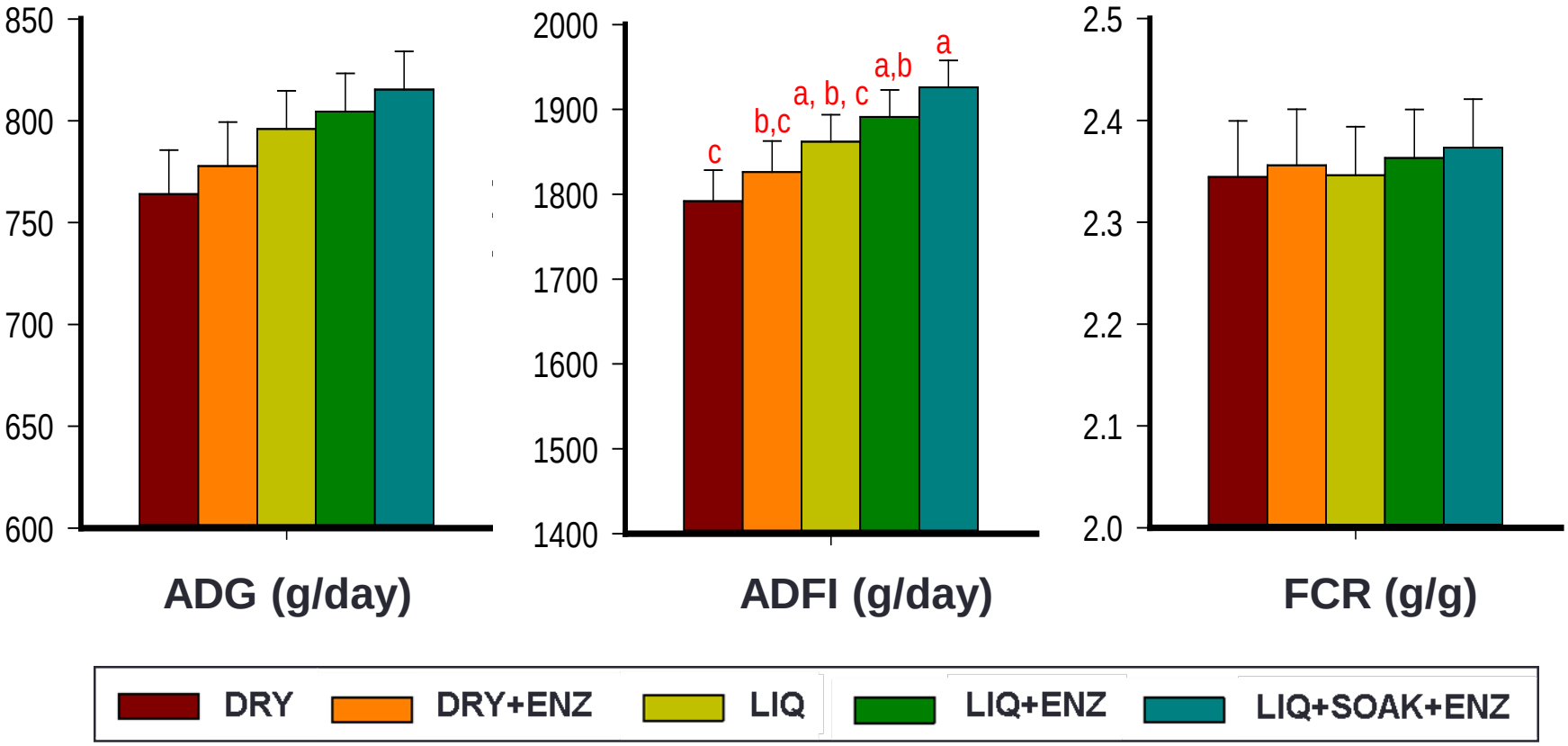
5 experimental diets:

- **T1:** Basal diet fed in **DRY** form
- **T2:** Basal diet fed in **DRY** form + **ENZYMES**
- **T3:** Basal diet fed in **FRESH LIQUID** form
- **T4:** Basal diet fed in **FRESH LIQUID** form + **ENZYMES**
- **T5:** Basal diet fed in **SOAKED LIQUID** form (8h soaking) + **ENZYMES**

Diet composition: Wheat / Barley based diet
10.05 MJ NE/kg
8.8 g SID Lys/kg (growing phase)
7.7 g SID Lys/kg (finishing phase)

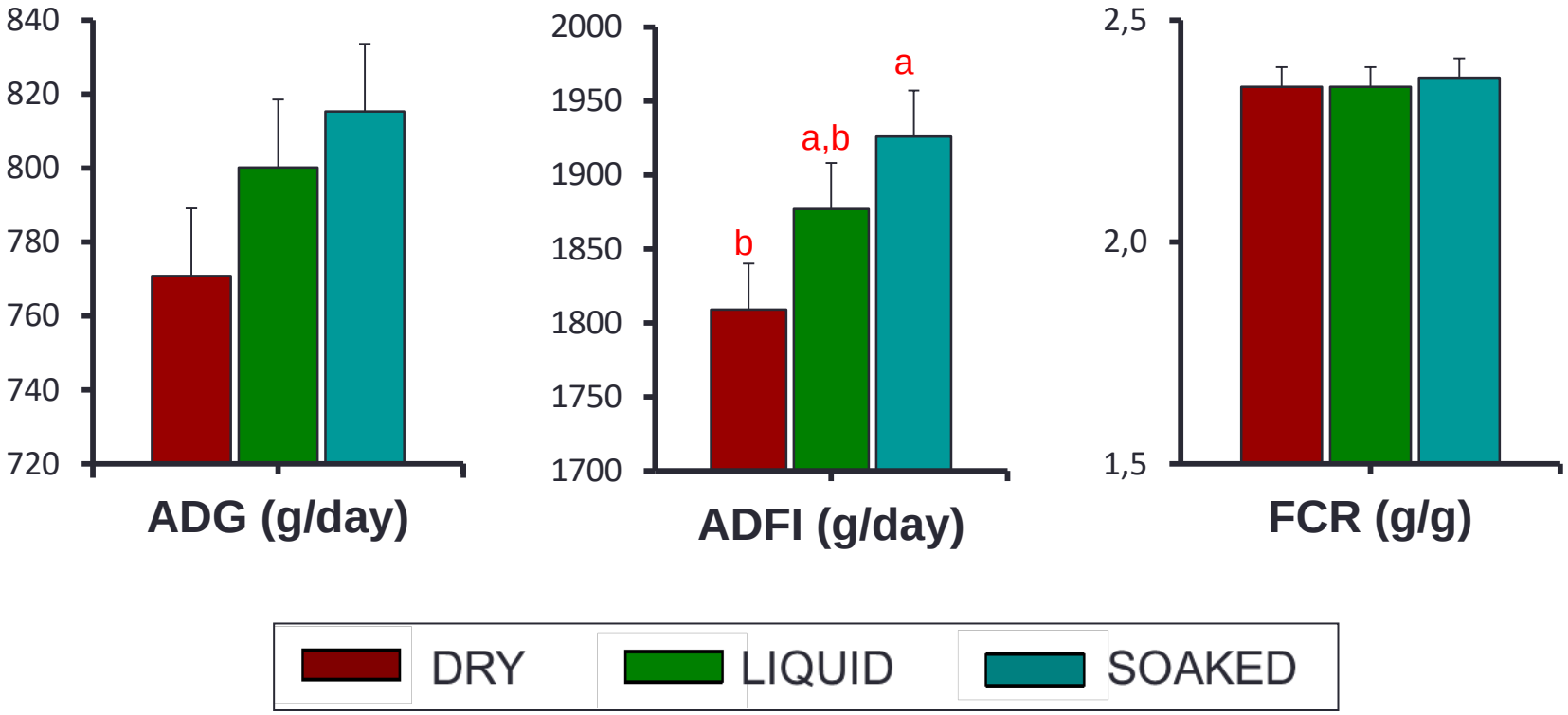
EXP. 1 : Results – Growth

Diet effect on growth performance: overall period



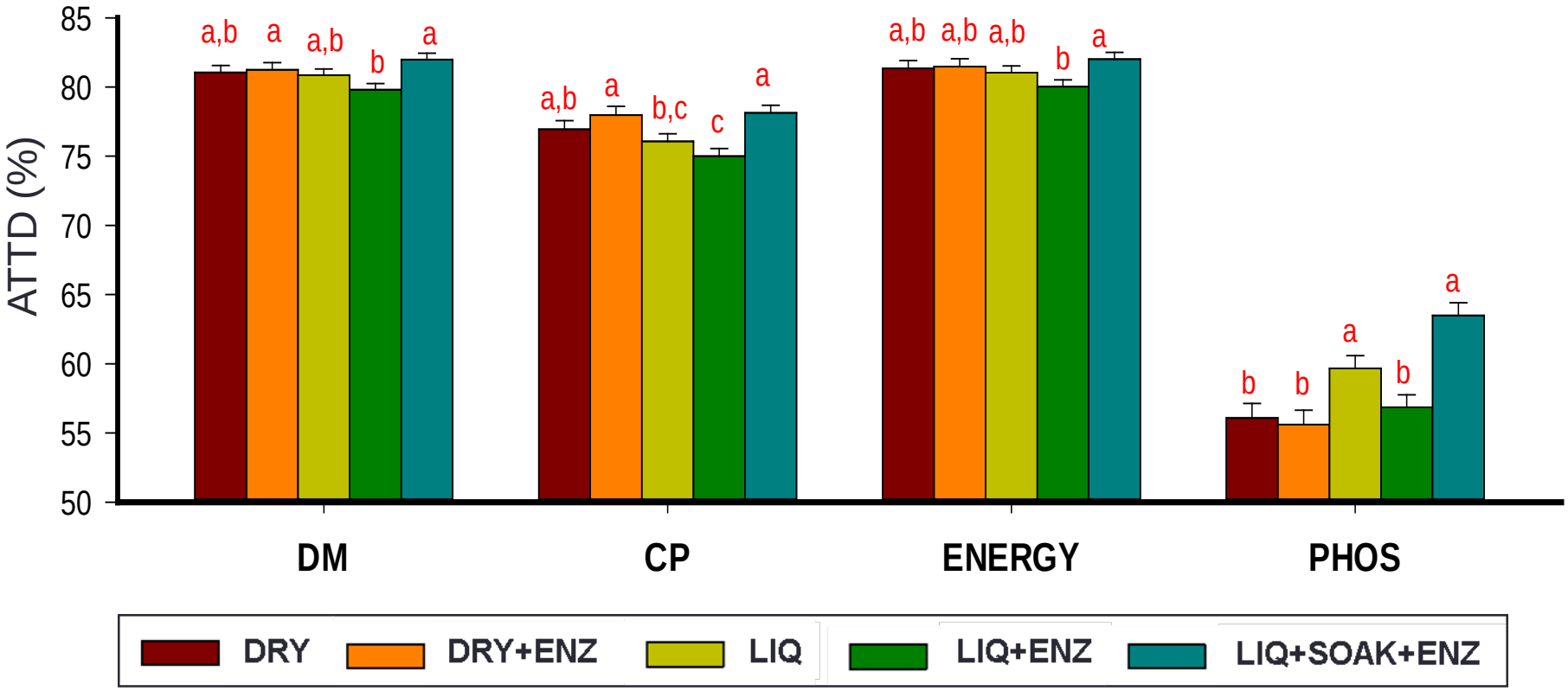
EXP. 1 : Results – Growth

Feed form effect on growth performance - overall period

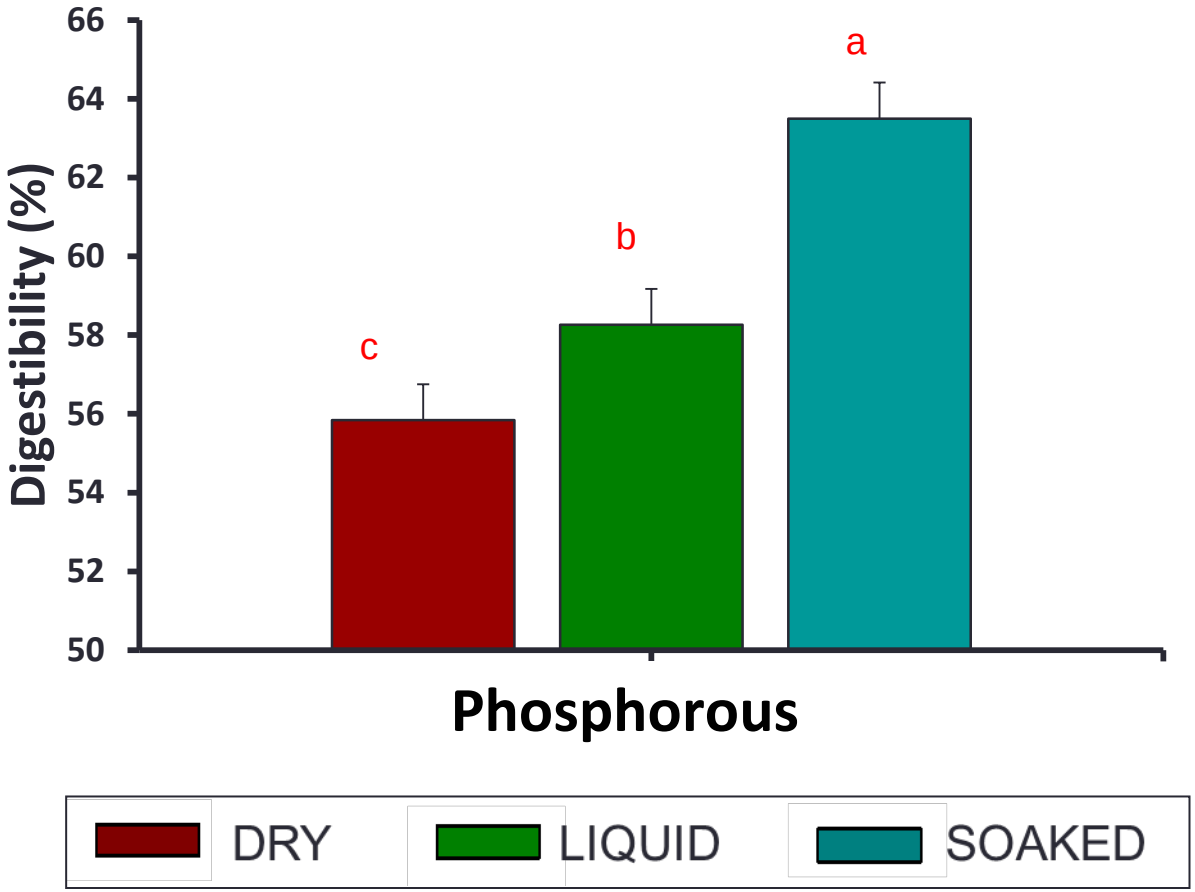


EXP. 1 : Results - Digestibility

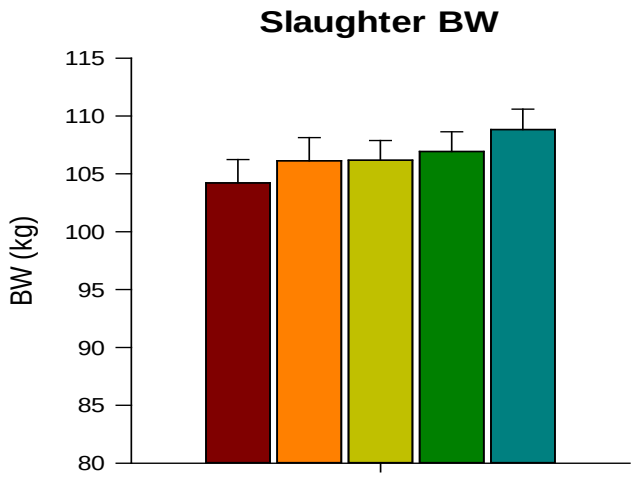
Diet effect on digestibility

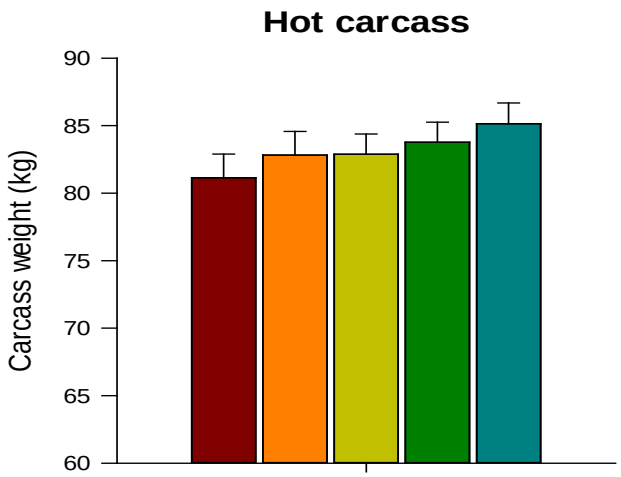


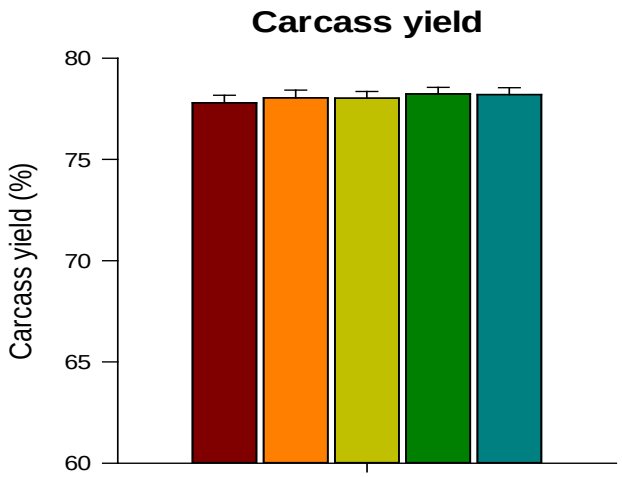
EXP. 1 : Results - Digestibility

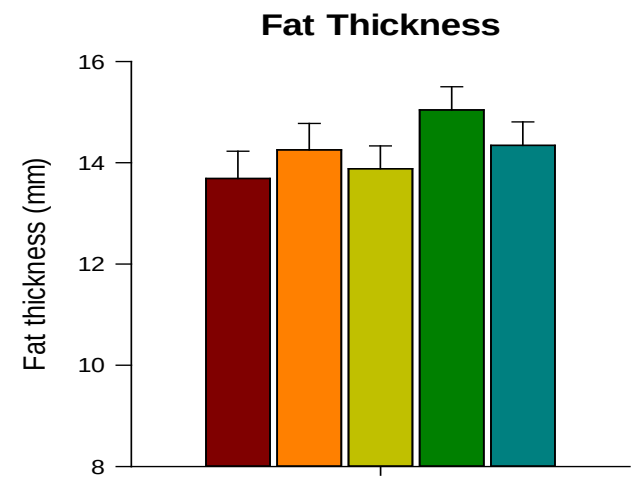


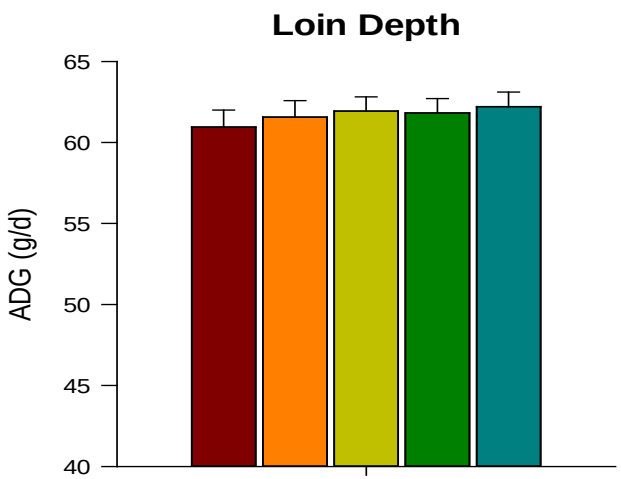
EXP. 1: Results – Carcass quality

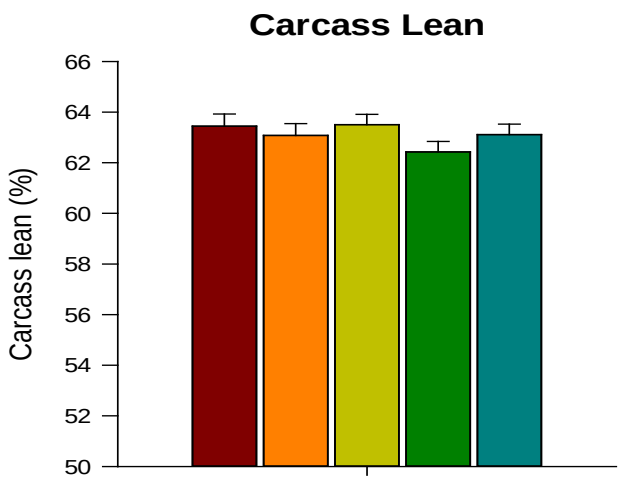












EXP. 1: Conclusions

- Soaking + Enzyme supplementation may improve ADG by increasing **feed intake** compared to dry diets
- Liquid feeding improved **phosphorous digestibility**
- **Similar FE** for dry, liquid and soaked diets
- **Similar carcass yield** and meat quality for all diets

EXPERIMENT 2

EXP. 2: Material and Methods

Enzymes: Xylanase + ² -glucanase

392 B@(MaxGro)
Exp. Unit: pen of 7 pigs
n= 14
30 ~ 105 kg LW

4 experimental diets:

- **T1:** Basal diet fed in **FRESH LIQUID** form
- **T2:** Basal diet fed in **FRESH LIQUID** form + **ENZYMES**
- **T3:** Basal diet fed in **SOAKED LIQUID** form (Only cereals soaked for 3h)
- **T4:** Basal diet fed in **SOAKED LIQUID** form + **ENZYMES** (Only cereals for 3h)

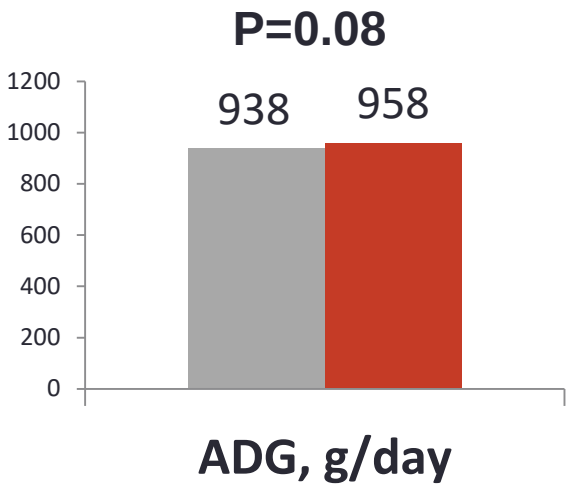
Diet composition: Wheat/barley/pollard based diet

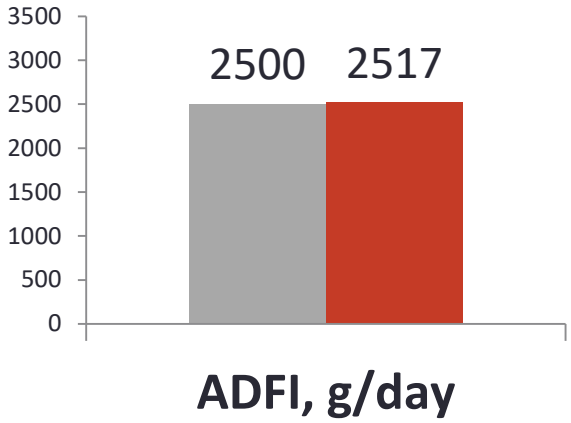
9.4 MJ NE/kg

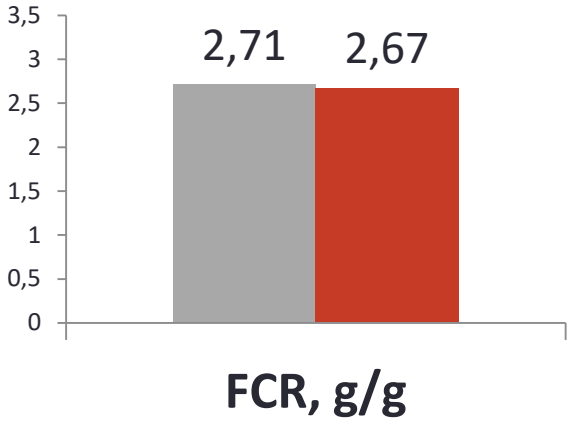
9.15 g SID Lys/kg

EXP. 2: Results – Soaking effect

Soaking effect on growth performance - overall period (33 – 99 kg LW)



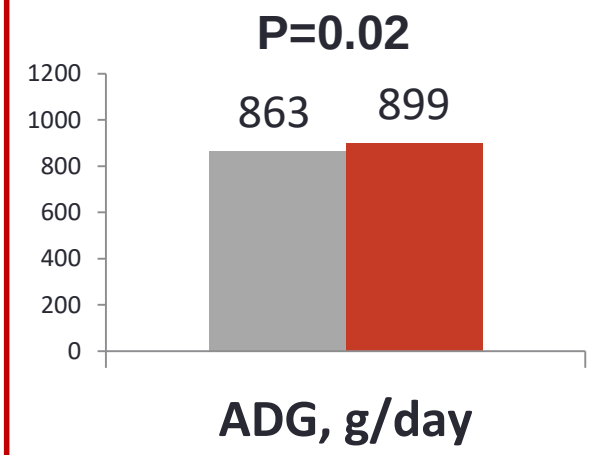


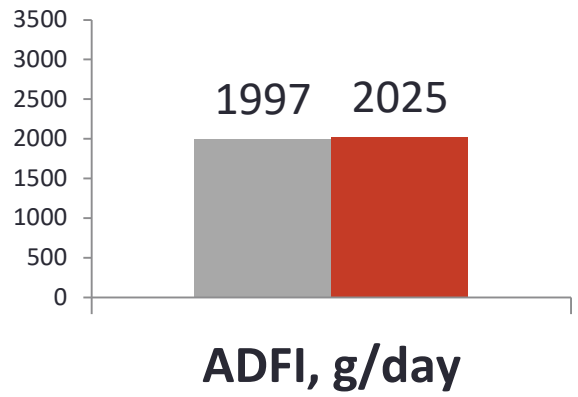


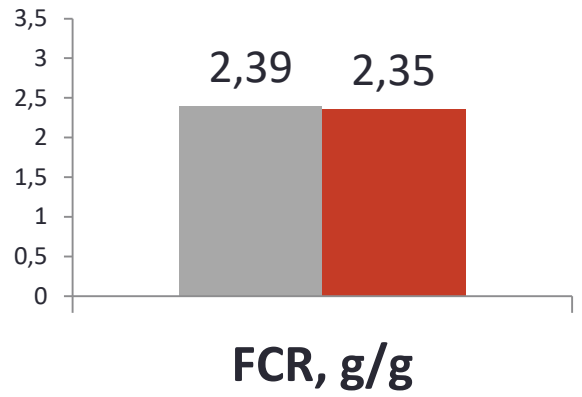
Fresh liquid diet

Cereal soaked 3h

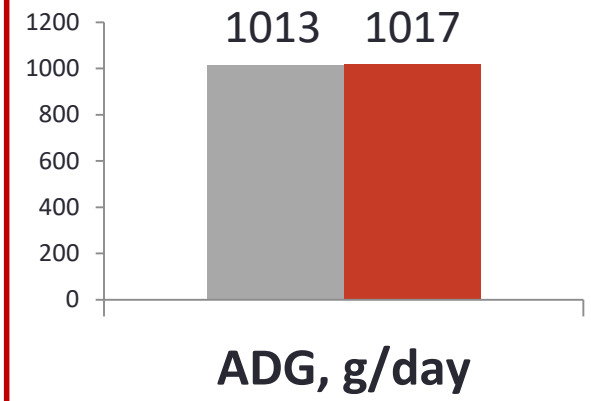
Soaking effect on growth performance

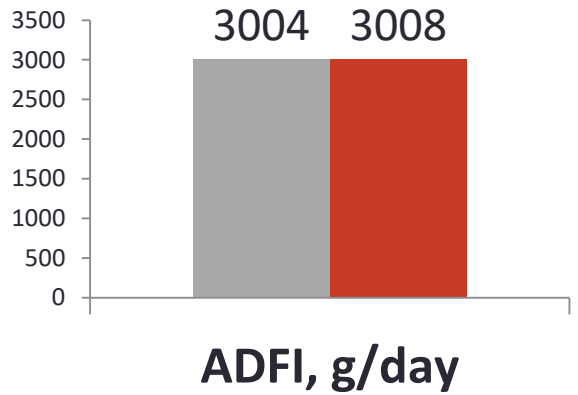


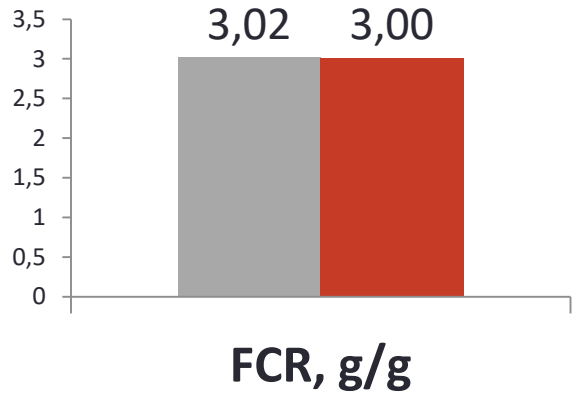




Growing phase *(33 – 51 kg live weight)*





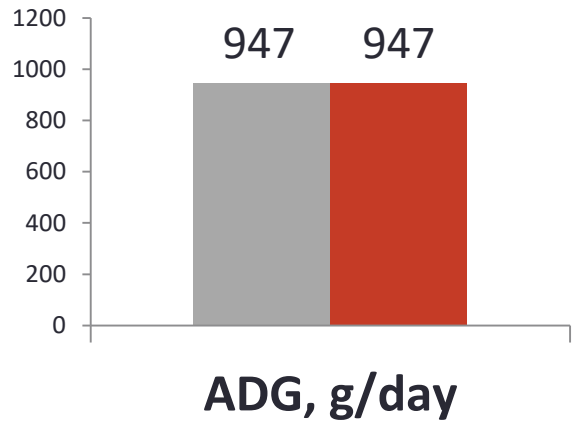


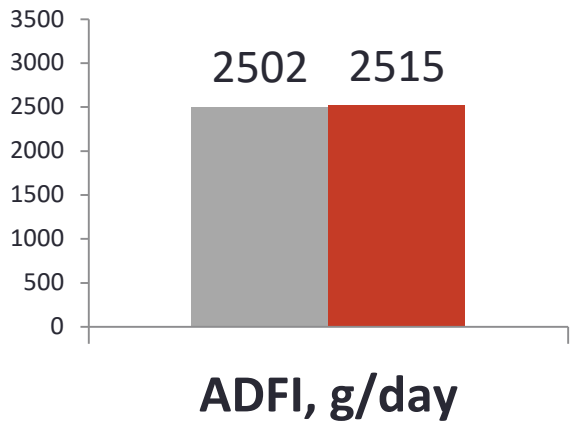
Finishing phase *(51 – 99 kg live weight)*

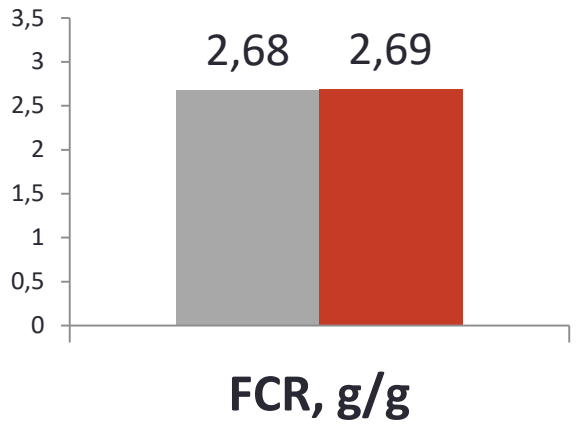
Fresh liquid diet **Cereal soaked 3h**

EXP. 2: Results – Enzyme effect

Enzyme effect on growth performance: overall period (33 – 99 kg LW)





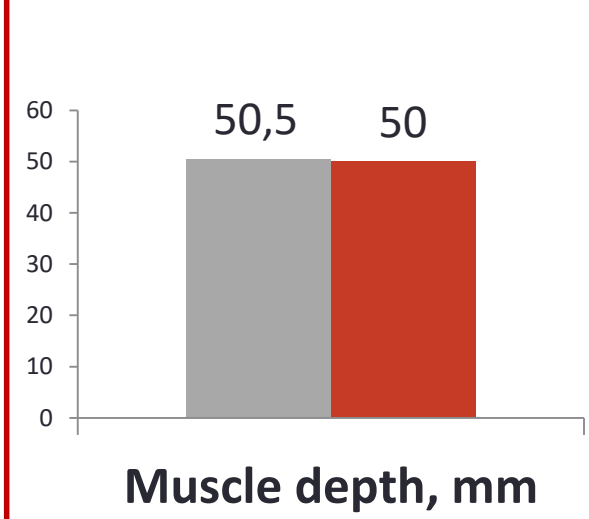


CONTROL

CARBOHYDRASE +

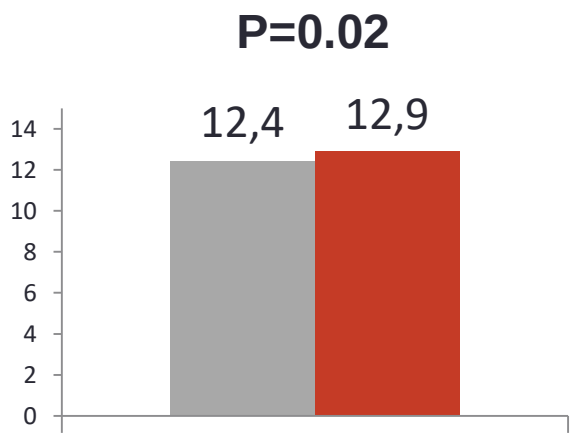
EXP. 2: Results – Enzyme effect

Enzyme effect on carcass quality



Muscle depth, mm

P=0.02



Fat depth, mm

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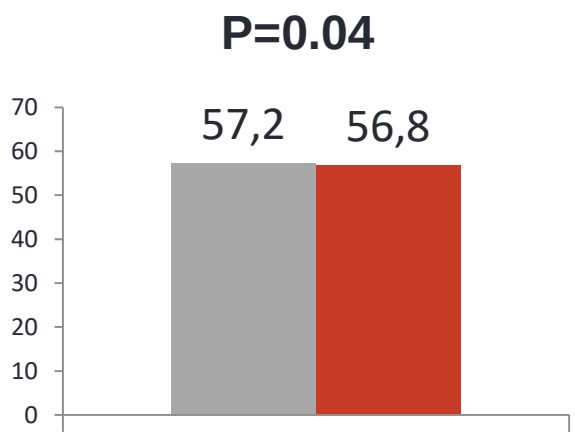
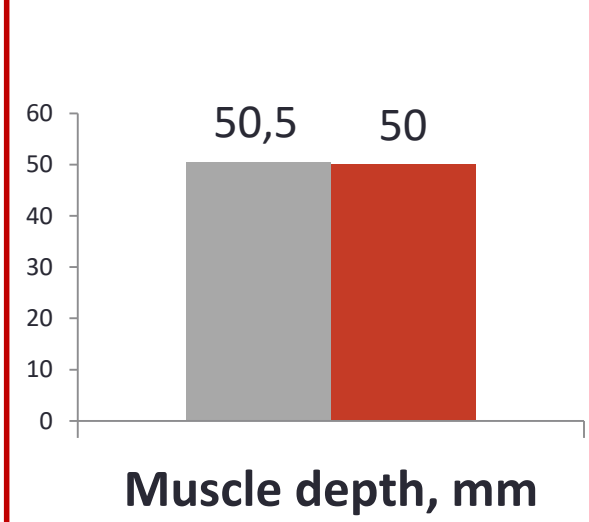


Lean meat, %

CONTROL **CARBOHYDRASE +**

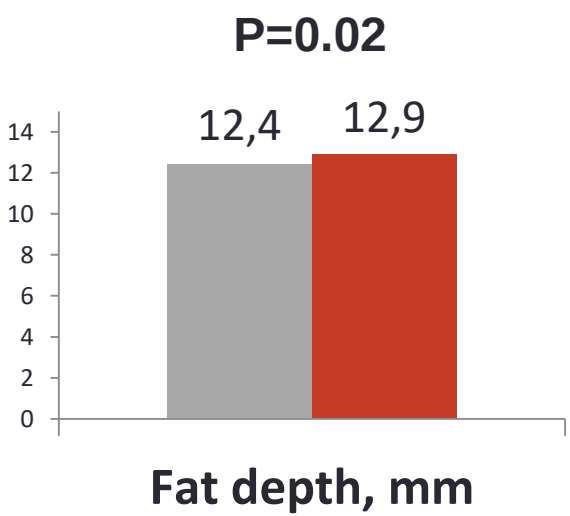
EXP. 2: Results – Enzyme effect

Enzyme effect on carcass quality



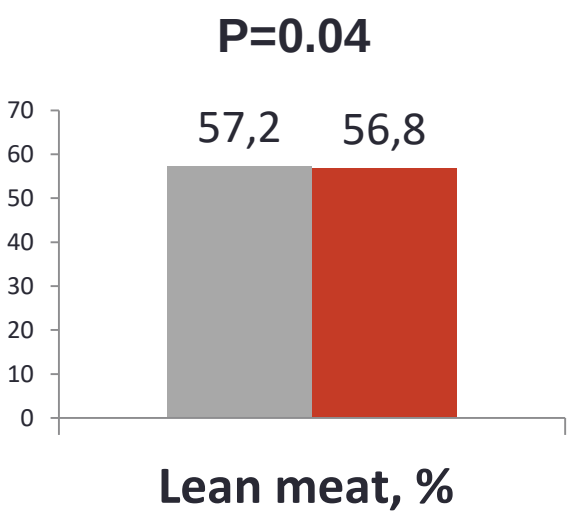
Muscle depth, mm

P=0.02



Fat depth, mm

P=0.04



Lean meat, %

Increased energy availability but insufficient AA for lean growth?

CONTROL **CARBOHYDRASE +**

EXP. 2: Conclusions

- Soaking the cereals for 3h prior to feeding improved ADG
- Enzyme supplementation did not affect ADG, ADFI and FCR
- Enzyme supplementation reduced lean meat yield
  - Increased energy availability?
  - Insufficient AA for lean growth?

FINAL REMARKS

Conclusions:

Benefits of soaking liquid diets:

- ↑ ADG by ↑ ADFI
- ↑ Nutrient digestibility, especially phosphorous

Limited benefits of Xylanase and β-glucanase in liquid diets

Future work:

- Best soaking time? Pre-fermentation of the cereal fraction?
- Phytase supplementation to liquid diets?

Acknowledgements

- ECO-FCE project (7th FP-EU) & partners
- Teagasc Walsh fellowship programme
- Co-workers from the Teagasc pig department & IRTA & WIT

Thank you

EXP. 1Basal Diet composition (I)

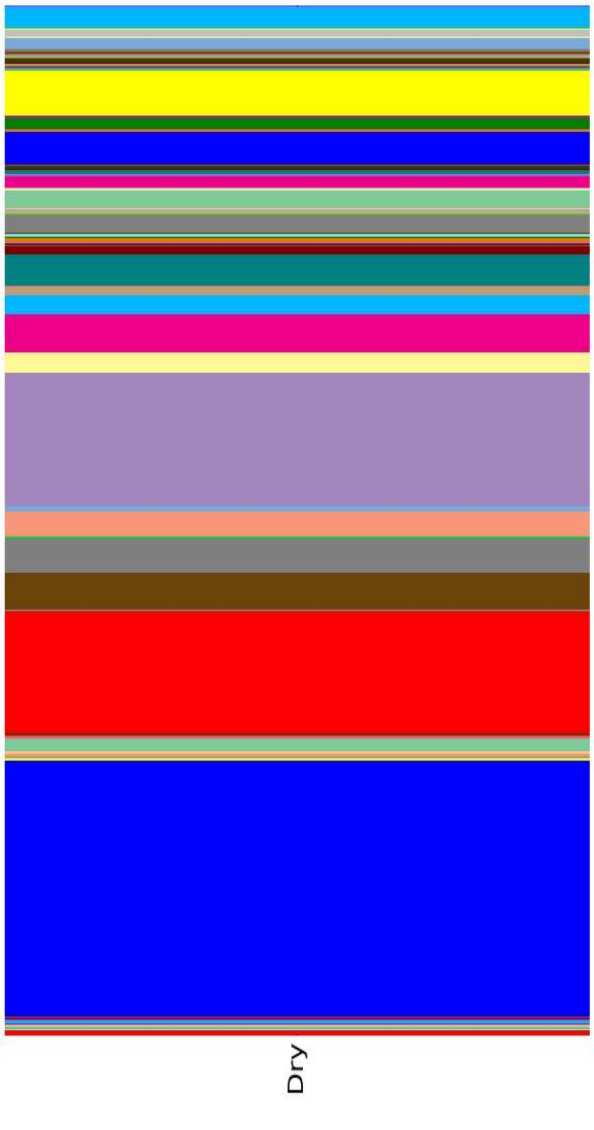
Ingredients (%)	Grower	Finisher
Wheat	35.00	35.00
Barley	37.85	36.80
Soybean meal, 44% CP	15.81	12.34
Rapeseed meal	4.81	9.30
Lard	3.77	4.19
Dicalcium phosphate	1.16	0.95
Calcium carbonate	0.40	0.44
Salt	0.36	0.35
L-Lysine-HCl	0.29	0.18
DL-Methionine	0.06	0.01
L-Threonine	0.07	0.01
L-Tryptophan	0.002	-
Ethoxiquin 66%	0.02	0.02
Minerals & vitamins*	0.40	0.40

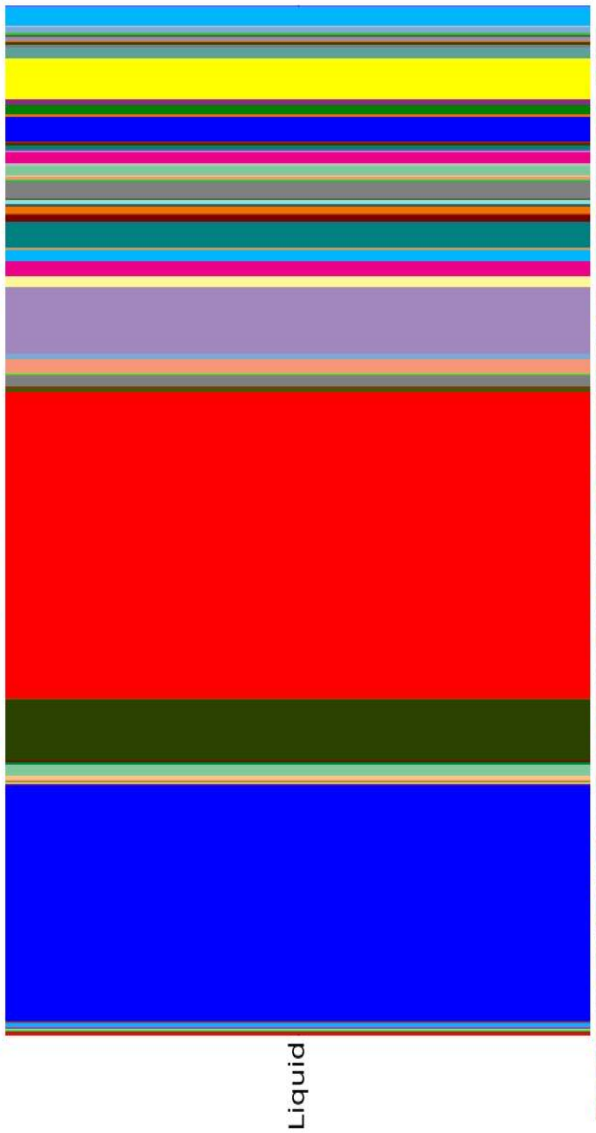
EXP. 1Basal Diet composition (II)

Nutrients	Grower	Finisher
Crude Protein (%)	16.4	16.1
Crude Fibre (%)	3.9	4.1
Fat (%)	5.5	6.0
Ash (%)	4.9	4.8
Energy (MJ NE/kg)	10.05	10.05
Calcium (g/kg)	6.7	6.6
Total phosphorous (g/kg)	5.4	5.3
Digestible P (g/kg)	2.8	2.6
SID-Lysine (g/kg)	8.8	7.7
SID-Threonine (g/kg)	5.5	4.9
SID-Methionine (g/kg)	2.8	2.5
SID-Methionine+Cystine (g/kg)	5.6	5.3
SID-Tryptophan (g/kg)	1.8	1.7

EXP. 1

Ion Torrent OTUs profiles, at genera level, grouped by feeding regimen





Legend	Taxonomy	Total count	Total %	Dry %	Liquid %
	k__Bacteria;Other;Other;Other;Other;Other	0	0.5%	0.6%	0.3%
	k__Bacteria;p__Bacteroidetes;Other;Other;Other;Other	0	0.2%	0.3%	0.1%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;Other;Other	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__;g__	0	0.4%	0.3%	0.5%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Bacteroidaceae;g__Bacteroides	0	0.1%	0.0%	0.1%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Porphyromonadaceae;g__Parabacteroides	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Prevotellaceae;Other	0	0.1%	0.2%	0.1%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__Prevotellaceae;g__Prevotella	0	23.9%	24.9%	22.9%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__S24-7;g__	0	0.2%	0.3%	0.2%
	k__Bacteria;p__Bacteroidetes;c__Bacteroidia;o__Bacteroidales;f__[Paraprevotellaceae];Other	0	0.1%	0.1%	0.1%
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	k__Bacteria;p__Firmicutes;Other;Other;Other;Other	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Firmicutes;c__Bacilli;o__Lactobacillales;f__Lactobacillaceae;Other	0	3.1%	0.2%	6.1%
	k__Bacteria;p__Firmicutes;c__Bacilli;o__Lactobacillales;f__Lactobacillaceae;g__Lactobacillus	0	20.9%	11.9%	29.9%
	k__Bacteria;p__Firmicutes;c__Bacilli;o__Lactobacillales;f__Streptococcaceae;g__Streptococcus	0	2.0%	3.7%	0.4%
	k__Bacteria;p__Firmicutes;c__Bacilli;o__Turicibacterales;f__Turicibacteraceae;g__Turicibacter	0	2.3%	3.4%	1.2%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;Other;Other	0	2.0%	2.5%	1.4%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__;g__	0	0.6%	0.5%	0.6%
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	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Clostridiaceae;g__	0	1.5%	2.0%	1.0%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Clostridiaceae;g__Clostridium	0	2.5%	3.7%	1.4%
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	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Epulopiscium	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Lachnospira	0	0.4%	0.3%	0.5%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Roseburia	0	1.8%	1.7%	1.8%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__Shuttleworthia	0	0.1%	0.2%	0.0%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Lachnospiraceae;g__[Ruminococcus]	0	0.3%	0.3%	0.3%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Peptostreptococcaceae;Other	0	0.1%	0.2%	0.1%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Peptostreptococcaceae;g__	0	1.4%	1.8%	1.0%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Ruminococcaceae;Other	0	0.3%	0.3%	0.2%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Ruminococcaceae;g__	0	1.0%	1.0%	1.0%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Ruminococcaceae;g__Butyricicoccus	0	0.2%	0.1%	0.2%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Ruminococcaceae;g__Oscillospira	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Ruminococcaceae;g__Ruminococcus	0	0.4%	0.5%	0.4%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;Other	0	0.3%	0.3%	0.2%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Anaerovibrio	0	2.8%	3.2%	2.5%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Dialister	0	0.3%	0.3%	0.2%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Megasphaera	0	0.9%	1.0%	0.9%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Mitsuokella	0	0.5%	0.3%	0.6%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Phascolarctobacterium	0	4.1%	4.3%	3.9%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__Veillonellaceae;g__Veillonella	0	0.7%	0.3%	1.1%
	k__Bacteria;p__Firmicutes;c__Clostridia;o__Clostridiales;f__[Mogibacteriaceae];g__	0	0.2%	0.2%	0.2%
	k__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Aeromonadales;f__Succinivibrionaceae;g__Succinivibrio	0	0.2%	0.2%	0.3%
	k__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Enterobacteriales;f__Enterobacteriaceae;Other	0	0.1%	0.1%	0.1%
	k__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Enterobacteriales;f__Enterobacteriaceae;g__Escherichia	0	0.8%	1.0%	0.6%
	k__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Pasteurellales;f__Pasteurellaceae;Other	0	0.1%	0.1%	0.0%
	k__Bacteria;p__Proteobacteria;c__Gammaproteobacteria;o__Pasteurellales;f__Pasteurellaceae;g__Actinobacillus	0	0.4%	0.7%	0.0%
	k__Bacteria;p__Tenericutes;c__Mollicutes;o__RF39;f__;g__	0	2.0%	2.1%	1.9%

EXP. 2 DIET COMPOSITION

Nutrient	Content
DM, g/kg	868.38
Protein, g/kg	159.67
Ash, g/kg	47.73
Fat, g/kg	20.48
Fibre, g/kg	42.58
NDF, g/kg	167.26
ADF, g/kg	53.92
DE Pig, MJ/kg	13.00
NEpigs, MJ/kg	9.39
Lysine, g/kg	10.61
SID LYSpig, g/kg	9.15
SID M+C as % LYS	5.26
SID THR as % LYS	5.55
SID TRP as % LYS	1.60
SID LYS/MJDE	0.70
Ca, g/kg	6.48
Phosphorus, g/kg	5.22
Digestible P, g/kg	2.40
Na, g/kg	1.35

Ingredient, kg/tone	Basal diet Control	Basal diet enzymes
Barley	377.3	377.2
Wheat	350.0	350.0
Soya Hi-Pro	135.0	135.0
Wheat pollard Irish	110.0	110.0
Limestone flour	12.5	12.5
Lysine HCl (78.8)	4.37	4.37
Mono DiCal Phos	3.68	3.68
Salt feed grade	3.0	3.0
L-Threonine (98)	1.09	1.09
Fat, soya oil	1.0	1.0
Vit-Min Mpk Finisher	1.0	1.0
DL-Methionine	0.8	0.8
Celite	0.3	0.3
Rovavio excel AP	0.0	0.1
Total	**1000.0**	**1000.0**