Novel Feeding Strategies for the Growing pig:
Simple vs Complex Nursery diets

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Nursery vs G/F pig performance

Two opposing views:

1. Conventional: *Pigs that perform better post-weaning will perform better up to market weight*
   - Consistent with negative effect of intra-uterine growth retardation on physiology and nutrient metabolism in growing pigs (e.g. Wu, 2006; Michiels et al., 2013; Kruger et al., 2013)
   - Based on regression analyses on large number of pigs, (e.g. Pollman, 1993; Mahan and Lepine, 1993; Mahan et al., 2004):
     - May be confounded with weaning age and weight or farm
     - Largely based on statistical analyses of performance data 'within' groups of pigs; not 'factorial' studies
   - An important incentive to maximize performance in the nursery & feeding pig starter diets that are highly fortified with complex ('expensive') ingredients and antibiotics

Costs per market pig ($/pig; Farrow-Finish)

	Base	
Feed	117.43	
Breeding herd	*18.28*	
Nursery	*18.15*	*(15% of feed & 10% of total)*
G/F	*81.01*	
Labour	13.20	
Other variable costs	25.55	
Fixed costs	20.74	
Total	176.93	

Also, consider antibiotic usage & ingredient quality

OMAF & MRA Swine Budget, Dec 2013

Nursery vs G/F pig performance

Two opposing views:

2. Alternative: *Reduced growth performance post-weaning has no impact on long-term growth performance:*
   - Starter pigs show compensatory growth following protein intake restriction (Wellock et al., 2007)
   - View is supported by recent observations in UK (MLC, 2007) Denmark (Callesen et al., 2006), Australia (Collins et al., 2013)
   - An argument to reduce diet costs and use of antibiotics
   - Growth recovery of growth may vary with cause of growth restriction (Nelssen et al., 1999):
     - recovery only after nutrient intake restriction, not when pigs are fed poor quality or antibiotic free diets ?

MLC studies: diets fed 2 weeks post-weaning

	Low CP (1.20% LYS)		High CP (1.6% LYS)	
	High Q	Low Q	High Q	Low Q
Cooked wheat	32.8	-	24.8	-
Cooked deh. oats	12.5	-	12.5	
Cooked corn	12.5	-	12.5	-
Fish meal	3.0	-	5.0	-
Hamlet protein	10.0	-	10.0	-
Skim milk	7.5		10.0	
Wheat	-	19.9	-	4.6
Corn	-	12.5	-	12.5
Deh. oats	-	12.5	-	12.5
Soybean meal	-	12.5	-	20.0
Full fat soya	-	17.5	-	27.5
Lactose	8.5	15.0	5.0	15.0

pigs weaned 29 ± 3.1 days & 9.9 ± 0.95 kg BW ; identical feeding programs after day 14

Wellock et al., 2009

MLC studies: growth performance

	diet CP		diet Quality		
	Low	High	High	Low	
Gain, g/d					
Weaning to d 14	201[a]	232[b]	232[a]	201[b]	P<.05
Day 14 to 32 kg	574	576	577	573	ns
32 to 105 kg	1079	1034	1073	1040	ns
Overall	807	797	807	797	ns
Feed : Gain, g/g					
Weaning to d 14	1.84[a]	1.59[b]	1.64	1.80	P=.09
Day 14 to 32 kg	1.58	1.56	1.57	1.57	ns
32 to 105 kg	2.46	2.47	2.45	2.49	ns
Overall	2.13	2.17	2.15	2.15	ns

pigs weaned 29 ± 3.1 days & 9.9 ± 0.95 kg BW; identical feeding programs after day 14

Wellock et al., 2009

MLC studies: growth performance

	diet CP		diet Quality		
	Low	High	High	Low	
Health indicators					
Fecal score, d14	2.02	2.02	1.96[a]	2.08[b]	P<.05
Health score, d14	1.09	1.05	1.03[a]	1.10[b]	P=0.05
fec. ETEC, cfu/g	5.80	5.00	4.68[a]	6.13[b]	P<.05
fec. Lac:Coli	1.26	1.29	1.34[a]	1.21[b]	P<.05
Carcass quality					
Carcass wt, kg	80.5	81.3	81.0	80.8	ns
P2 backfat, mm	12.0	12.5	12.4	12.1	ns
Lean%	60.1	60.2	60.2	60.1	ns

pigs weaned 29 ± 3.1 days & 9.9 ± 0.95 kg BW; identical feeding programs after day 14

Wellock et al., 2009

Research Hypotheses
(proposal to Ontario Pork 2010)

1. In order to optimize carcass quality and growth performance up to market weight newly-weaned pigs should be fed an antibiotic containing complex diet.
2. Based on a select number of biomarkers the negative impact of sub-optimal nutrition during the first few weeks post-weaning on subsequent growth performance can be predicted.

Research objectives:

1. Investigate the effect of growth rate of pigs in the nursery - as affected by diet complexity and/or high versus low usage of in-feed antibiotics - on subsequent growth performance and carcass quality.
2. Explore selected indicators of the health status, immune function and growth performance (i.e. plasma cytokines, hormones, expression of genes regulating nutrient use, growth and immune function) to assess and predict the impact of external stressors on growth performance during both the nursery and growing-finishing phase.

Benefit of Research

1. Either…..reduction in nursery feed costs without long-term effects on pig performance

   Or…....better assessment of value of complex nursery feeding programs.
2. Biomarkers to predict whether stressors imposed on pigs during the post-weaning period will cause long-term reductions in growth performance

Impact of nursery feeding programs on subsequent growth performance and carcass quality

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Ontario Pork — Swine Innovation Porc — Ontario Ministry of Agriculture, Food and Rural Affairs — University of Guelph

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Methodology

- 5 blocks of 96 newly weaned pigs (7.02±0.07 kg)
- 4 treatment groups in a 2x2 factorial design based on diet complexity (Diet) and antibiotic usage (AB)
- Pigs assigned to pens in a randomized complete block design with 3 pens per treatment per block
- Pens of pigs moved to growing-finishing rooms 6 weeks post-weaning and fed common diets

Nursery diet compositions (% as fed)

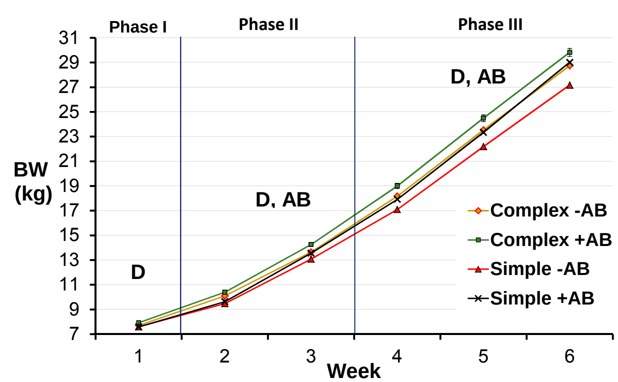
	Complex			Simple		
Phase	I	II	III	I	II	III
Corn	18.85	38.7	50.23	47.14	49.57	47.25
Wheat				10	10	10
Barley	25	25	25			
SBM, 47.5%	**10.8**	**15**	**21**	**24**	**34**	**37**
Whey	**20**	**8**	**-**	**8**	**-**	**-**
Herring ml, %	**5**	**3**	**-**	**5**	**-**	**-**
Blood plasma, AP920	**4.5**	**2**	**-**	**-**	**-**	**-**
Blood ml, spray dried	**-**	**2**	**2**	**-**	**-**	**-**
Oat groats	10	-	-	-	-	-
Calcium propionate	0.4	0.4	0.2	-	-	-
Calcium formate	0.4	0.4	0.2	-	-	-
Fat, AA, vit, min	+	+	+	+	+	+
DE, MJ/kg	14.43	14.30	14.49	14.93	14.92	14.96
SID Lys, %	1.35	1.25	1.17	1.21	1.25	1.17

With or without Chloratetracycline (Aureomycin 220; 273 g/1000 kg)

Measurements / Analysis

- Body weight, feed intake measured weekly in the nursery, bi-weekly in growing-finishing barn until the 17th week post-weaning
- Carcass quality assessed when pigs were slaughtered at about 115 kg BW
- Serial blood sampling (wk 0, 2, 4, 6, 10, 14 & 17 post-weaning) and tissue plus body composition analyses in a subsample of pigs (wk 2, 8, 12, 17 post-weaning)

Average Body Weight per Treatment in Nursery Phase, kg



D, AB indicates *P-value* <0.05 for Diet, AB respectively

Average Daily Gain, g

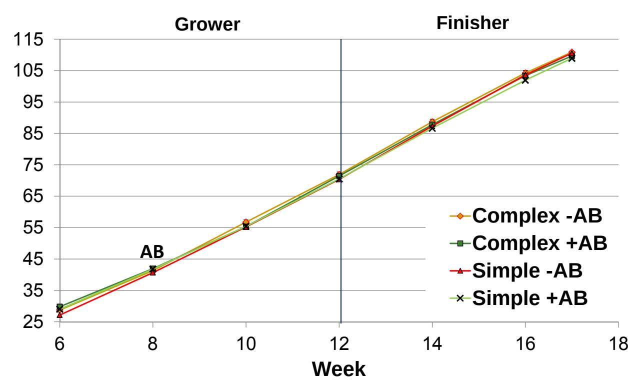
Period	Compl. -AB	Compl. +AB	Simple -AB	Simple +AB	SE	*AB*	*Diet*	*AB x Diet*
	Treatment					***P-values***		
Wk 1	99	129	81	78	10.41	0.16	<0.01	0.09
Wk 2-3	427	451	388	425	14.23	<0.01	<0.01	0.50
Wk 4-6	717	733	661	706	23.76	0.03	<0.01	0.28

Gain:Feed

Period	Compl. -AB	Compl. +AB	Simple -AB					
	Treatment							
Wk 1	0.54	0.62	0.45	0.47	0.04	0.16	<0.01	0.36
Wk 2-3	0.79	0.78	0.74	0.76	0.02	0.40	0.01	0.26
Wk 4-6	0.57	0.57	0.56	0.59	0.02	0.16	0.57	0.08

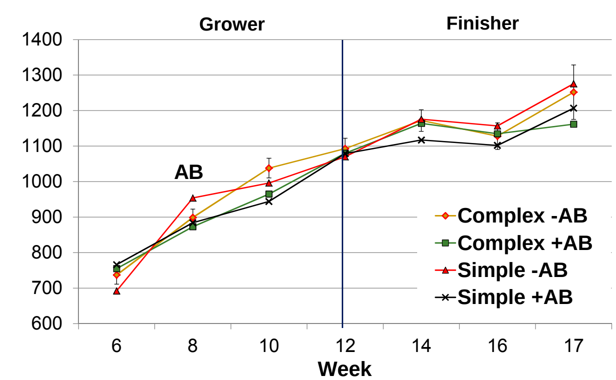
No differences among treatments in Phase III may indicate early onset of recovered growth performance

Average BW per Treatment in Grower-Finisher Period, kg



AB indicates significant effect of AB

Average Daily Gain per Treatment in Growing-Finishing Phase, g



AB indicates *P-value* <0.05 for AB

Wean-to-Finish Average Daily Gain, g

	Treatment					P-values		
Period	Compl. -AB	Compl. +AB	Simple -AB	Simple +AB	SEM	*AB*	*Diet*	*AB x Diet*
Phase I	99	129	81	[illegible]	[illegible]	[illegible]	[illegible]	09
Phase II	427	451	388	[illegible]	[illegible]	[illegible]	[illegible]	50
Phase III	717	733	661	[illegible]	[illegible]	[illegible]	[illegible]	28
Grower	1010	973	1007	969	26.9	0.02	0.82	0.995
Finisher	1170	1152	1188	1129	48.1	0.12	0.92	0.41
Overall	883	872	872	853	28.4	0.13	0.12	0.71

No effect of treatment on overall ADG despite differences during the nursery period

Wean-to-Finish Gain:Feed

	Treatment					P-values		
Period	Compl. -AB	Compl. +AB	Simple -AB	Simple +AB	SEM	*AB*	*Diet*	*AB x Diet*
Phase I	0.54	0.62	0.45	0.47	0.04	0.16	<0.01	0.36
Phase II	0.79	0.78	0.74	0.76	0.02	0.40	0.01	0.26
Phase III	0.57	0.57	0.56	0.59	0.02	0.16	0.57	0.08
Grower	0.45	0.45	0.46	0.45	0.02	0.35	0.67	0.66
Finisher	0.35	0.35	0.35	0.36	0.01	0.56	0.36	0.92
Overall	0.42	0.43	0.43	0.43	0.01	0.12	0.15	0.97

Carcass Quality

	Treatment					P-values
	Complex -AB	Complex +AB	Simple -AB	Simple +AB	SEM	*Diet*
Final live weight, kg	110.9	109.7	110.6	109.0	0.86	0.56
Carcass weight, kg	95.5	95.5	95.3	95.2	0.74	0.68
Lean yield, %	60.0	60.2	60.3	60.2	0.30	0.48
Fat depth, mm	20.4	20.0	19.5	19.4	0.68	0.19
Muscle depth, mm	63.2	63.2	61.2	62.3	1.15	0.07

Meat Quality & Carcass Composition

- No treatment effect on loin meat quality or the weight of primal and retail cuts (except primal belly)
  - Simple nursery diets tended to increase belly weight
- No consistent differences in carcass composition or rates of body protein deposition (Pd) and body lipid deposition (Ld)
  - Simple nursery diets tended to increase Pd in finisher phase
- No effect of nursery diet complexity or in-feed antibiotic usage on final carcass composition

Feed Cost[1] ($/pig)

	Diet			
	Complex -AB	Complex +AB	Simple -AB	Simple +AB
Nursery	18.79			14.82
Total	94.78	94.37	89.31	88.20

$5 per pig in feed cost savings

[1]Feed cost from weaning to week 17 post-weaning. Calculated from ADFI and diet costs ($/1000 kg) as follows: Phase I – Complex Ab-, 1136 and Simple Ab-, 680; Phase II – Complex Ab-, 740 and Simple Ab-, 441; Phase III – Complex Ab-, 427 and Simple Ab, 393-; 17.50 added to each Ab+ diet; Grower, 367; Finisher, 345.

Mortality (% of pigs weaned)

	Block					
Treatment	1	2	3	4	5	1 to 5
Complex -AB	8.3	0.0	3.3	13.3	10.0	*7.2*
Complex +AB	4.2	16.7	16.7	16.7	16.7	*14.5*
Simple -AB	12.5	20.8	10.0	10.0	26.7	*15.9*
Simple +AB	4.2	16.7	13.3	13.3	30.0	*15.9*
Block total	*7.3*	*13.5*	*10.8*	*13.3*	*20.8*	

Growth Performance in 5th Block

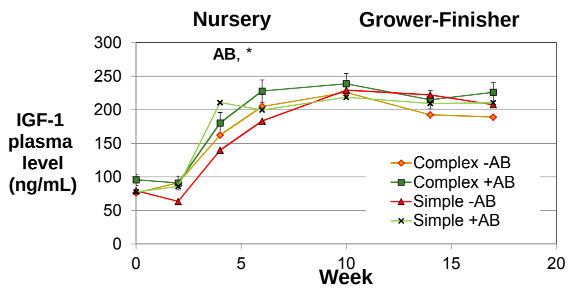
	Treatment			
	Complex -AB	Complex +AB	Simple -AB	Simple +AB
Wk 6 BW, kg	28.13	29.60	24.61	25.94
Wk 17 BW, kg	110.9	111.4	108.4	106.0
Wk 1-6 ADG, g	508	533	415	428
Wk 1-17 ADG, g	874	880	853	835
Wk 1-6 G:F	0.63	0.64	0.59	0.60
Week 1-17 G:F	0.45	0.44	0.44	0.46

Conclusions (1/2): growth performance

- Feeding simple nursery diets reduced growth performance in the nursery
- Excluding AB from nursery diets reduced growth performance in the nursery
  - Induced subsequent compensatory growth
- No effect of nursery die complexity on days to market, overall feed efficiency, body composition, meat quality or carcass quality

Physiological mechanisms involved in periods of reduced and improved growth

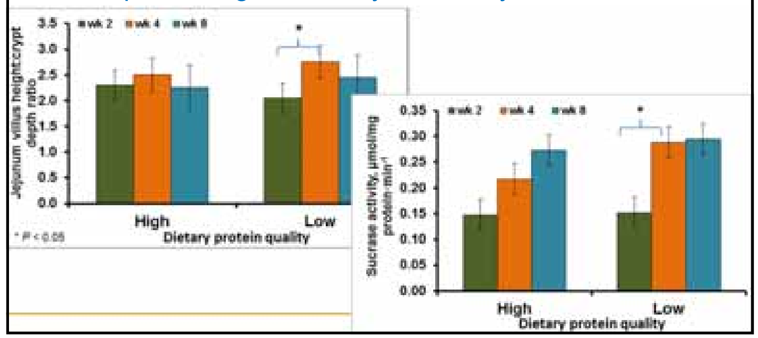
- 1. Endocrinology
  - Short term, but no long term effects on plasma levels of IGF-1, T3 & T4 (Skinner, 2012)



AB indicates significant effect of AB; * indicates a trend towards an interaction (Skinner, 2012)

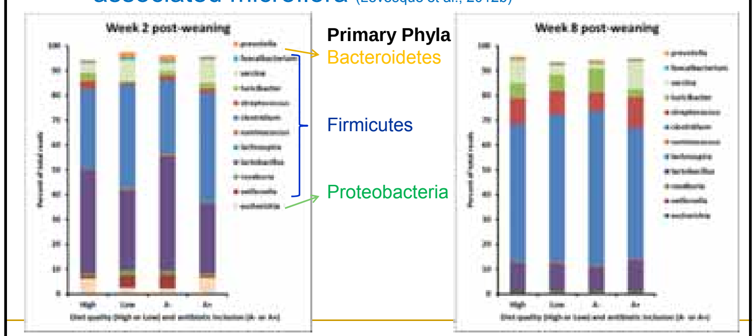
Physiological mechanisms involved in periods of reduced and improved growth

- 2. Digestive capacity
  - Increased villus height:crypt depth ratio and improved digestive enzyme activity (Levesque et al., 2012a)



Physiological mechanisms involved in periods of reduced and improved growth

- 3. Gut microbiology
  - Long term impact of high AB on mucosa associated microflora (Levesque et al., 2012b)



Interaction between week post-weaning and nursery diet on ileal mucosa bacterial species

	Week 2		Week 8		
	High	Low	High	Low	sem
Clostridium leptum	$11.6^{a,b}$	27.2^{a}	5.3^{b}	1.0^{b}	6.4
Clostridium paraputrificum	$3.2^{a,x}$	$0.8^{a,x}$	6.5^{x}	$13.3^{b,y}$	2.4
Escherichia albertii	2.2^{a}	0.42^{b}	0.09^{b}	0.05^{b}	0.5

	Week 2		Week 8		
	A-	A+	A-	A+	sem
Veillonella parvula	2.1^{x}	0.08^{y}	0.09^{y}	0.03^{y}	0.6
Clostridium sordellii	0.60^{x}	$4.6^{x,y}$	9.2^{y}	2.6^{x}	2.2
Clostridium difficile	0.14^{x}	1.3^{y}	$0.78^{x,y}$	$0.54^{x,y}$	0.4
Clostridium bifermentans	0.67^{a}	6.8^{b}	$2.8^{a,b}$	$3.1^{a,b}$	1.6
Lactobacillus salivarius	1.2^{a}	0.11^{a}	4.9^{b}	0.20^{a}	0.8

Potentially pathogenic, potentially beneficial, non-virulent (Levesque et al., 2012b)

Interaction between week post-weaning and nursery diet on ileal mucosa bacterial species

	Week 2		Week 8		
	High	Low	High	Low	sem
Clostridium leptum	$11.6^{a,b}$	27.2^{a}	5.3^{b}	1.0^{b}	6.4
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	A-	A+	A-	A+	sem
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Physiological mechanisms involved in periods of reduced and improved growth

- 4. Gene expression (Complex+AB vs Simple –AB)
  - In liver, 82 genes differentially expressed
  - For some genes (growth axis, immune function) expression remained altered up to 8 weeks post-weaning

Gene Symbol	Gene Name	Fold Change (simple/complex)	P-value
ARG1	Arginase 1	1.79	0.056
CPS1	Carbamoyl phosphate synthase 1	1.56	0.057
SLA-DMA, B	Swine leukocyte antigen DMA	0.55	< 0.078
SLA-DQA, B1	Swine leukocyte antigen DMA	0.51	< 0.057
SLA-DRA, B1	Swine leukocyte antigen DMA	0.56	< 0.070
GPX1	Glutathione peroxidase 1 (cellular)	1.52	0.057
GPX3	Glutathione peroxidase 3 (plasma)	2.78	0.057
NR3C1	Glucocorticoid receptor	0.53	0.066
TXNIP	Thioredoxin interacting protein	0.59	0.057

(Rudar et al., 2012)

Conclusions (2/2): Physiology

Nursery diet complexity:

- Short-term (no long-term) effect on
  - Plasma levels of key hormones involved in growth and energy partitioning
  - Digestive function
- Short and long-term effects on:
  - Liver gene expression (growth and immune function)
  - Gut microbiology

Implications

- No impact of nursery diet complexity on wean-to-finish growth performance or carcass value
  - Reduced nursery feed costs creates opportunity for increased profits
- Interactions between nursery diet complexity and immune response – during a severe disease challenge - requires further exploring
  - May be mediated through long-term changes in gut micro-flora and expression of genes involved in the immune response

Related and additional/current initiatives at the University of Guelph

- Exploring bio-markers for growth of nursery pigs
- Simple assessment of robustness of pigs fed nursery diets of different complexity (high, low, very low)
- Interactive effect of nursery diet protein quality and ω-3 fatty acids (from fish oil) on performance and immune response

Epidemiological investigation into the association between biomarkers, health and growth performance in nursery pigs

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BMC Veterinary research (2013) 9:247

Objective

- Investigate association between growth performance, health and potential bio-markers (hepatic gene expression, plasma hormone levels, single nucleotide polymorphisms (SNPs) for growth and immune function related genes) in nursery pigs across diverse commercial farm condition

Study design

- Eight farms, 168 pigs (21 on each farm)
- At weaning: tagged, weight, blood, feces
- At 2 weeks post-weaning: blood, feces
- At 5 weeks post-weaning: weight, blood, feces, tissues
- Diseases tested: PRRS, Swine influenza, *Salmonella*, ETEC, MRSA, *Lawsonia*, *Brachyspira*
- Survey: sow parity, farrowing date, live born, stillborn, # of pigs, diseases history over the past year, pig flow, vaccination, drug use

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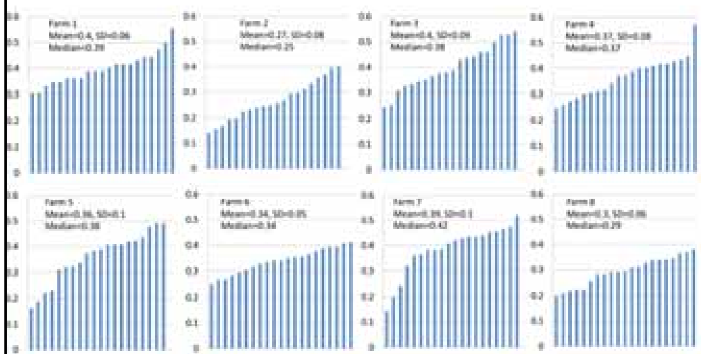
Average Daily Gain (kg) of 164 pigs



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Assessment of health & potential biomarkers

- Pathogens
  - *Salmonella* & ETEC – fecal culturing
  - *Lawsonia* – PCR of ileum content
  - *Brachyspira* – both culture and PCR in colon content
  - PRRS – PCR in serum
  - MRSA & Swine Influenza – in nasal swabs
- SNPs in innate disease resistance genes:
  - fautr, fbprom2, gal4a, gal4b, gal4c, ma1a, ma2, maintr, masp2, mcpr1, mcpr3a, mcpr4, mcpr5, spa1, spa3, tlr1, tlr2a, tlr4c, tlr5b, tlr5c, and tlr5d
- Liver gene expression:
  - Cytokines: IL-1β, IL-2, IL-4, IL-6, IL-8, IL-10, IL-18, IFN-α, IFN-γ, TNF-α, CRP, Hp, SAA
  - Growth factors: IGF1, IGFBP3, and GHR
- Plasma levels:
  - IGF-1 and IGFBP3

Epidemiological studies: Conclusions and Implications

- Clear associations between expression of growth regulating genes (especially GHR and IGFBP-3) in liver and growth performance across swine production systems
- Promising genetic markers (SNPs) for identifying pigs that carry less disease and show improved growth performance (GAL-4C, MASP-2, and TLR-5B)
- ➢ Associations requires further testing to become useful biomarkers in animal selection and management

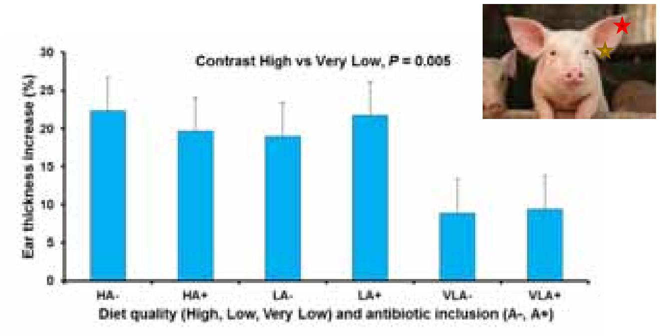
Simple assessment of piglet robustness in relation to nursery diet quality and feeding

C. L. Levesque, E. Miller
C. H. Zhu, and C. F. M. de Lange

SDSU · Ontario Pork · Swine Innovation Porc · Ontario Ministry of Agriculture, Food and Rural Affairs · University of Guelph

	High Quality			Low Quality			Very Low Quality		
	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
days on feed	7	14	21	7	14	21	7	14	21
Ingredient composition, %									
Corn (NRC; 8.3% CP)	18.85	38.7	50.23	47.14	49.57	47.25	62.79	58.04	53.6
Wheat, soft red winter				10	10	10			
Barley, 6 row	25	25	20						
Whey, dried	20	8		8					
AV fat blend / tallow	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Fishmeal, herring	5	3		5					
Blood plasma, AP920	4.5	2							
Blood meal, spray dried		2	2						
Soybean meal 48 (NRC)	10.8	15	21	24	34	37	30	35	40
Oat groats	10								
Lysine.HCl	0.3	0.25	0.35	0.16	0.25	0.05	0.34	0.23	
Methionine	0.18	0.18	0.18	0.06	0.11		0.13	0.08	
Threonine	0.1	0.12	0.16	0.04	0.09		0.12	0.05	
Tryptophan	0.02	0.02	0.02				0.02		
Limestone	0.5	0.58	0.86	1	1.18	1.1	1.5	1.5	1.5
Salt	0	0.2	0.3	0.2	0.3	0.3	0.5	0.5	0.5
Monocalcium phosphate	0.8	1	1.35	1.3	1.4	1.2	1.5	1.5	1.3
Calcium formate	0.4	0.4	0.2						
Calcium propionate	0.4	0.4	0.2						
Sweetener, saccharine	0.05	0.05	0.05						
Vitamin & mineral mix	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Nutrients contents									
DE, MJ/kg	14.43	14.30	14.49	14.93	14.92	14.96	14.84	14.86	14.90
Crude Protein, %	20.52	19.76	18.67	21.05	21.78	22.69	19.96	21.74	23.45
total LYS, %	1.507	1.391	1.293	1.356	1.391	1.318	1.34	1.39	1.35
SID LYS, %	1.351	1.248	1.170	1.209	1.251	1.170	1.21	1.25	1.19

Starter diet quality affects delayed type sensitivity (cell mediated immune response) following vaccination with an antigen (*C. albicans*)



Intradermal administration of *C. albicans;* Increase over baseline (mean ± sem) from Period 1 and average over 3 time points.

Impact of nursery diet quality and fish oil supplementation on growth performance and immune response in post-weaning pigs

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Objectives

- To evaluate the effect of including **5% fish or corn oil** in **low and high protein quality** nursery diets on:
  - Growth performance
  - Immune responses (e.g. antibody and cell-mediated)

Materials and Methods

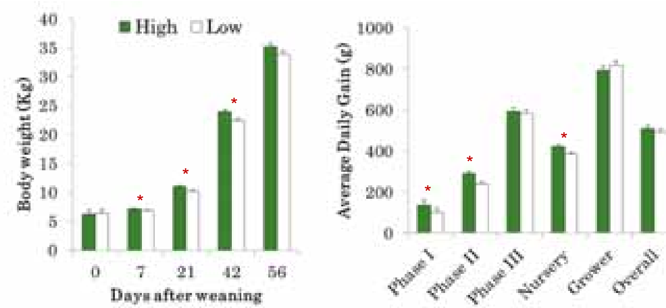
- 4 dietary treatments
  - 2 x 2 factorial arrangement
  - Protein Quality- **High** vs. **Low**
  - 5 % Oil -**Corn** vs. **Fish**
- Fed from 0 - 6 wk post-weaning in 3 Phases
  - Phase I, 0-7 d
  - Phase II, 8-21 d
  - Phase III, 22-42 d
- Common grower diet for 2 wk

Ingredients	High Quality Phase I	High Quality Phase II	High Quality Phase III	Low Quality Phase I	Low Quality Phase II	Low Quality Phase III
Corn	32.50	46.10	53.00	45.30	41.00	36.90
Soybean meal	**10.00**	**15.0**	**21.00**	**30.00**	**35.00**	**40.00**
Soybean isolate	**9.30**	**3.00**				
Whey, dried	**20.00**	**8.00**				
Blood plasma	**4.50**	**2.00**				
Blood meal		**2.00**	**2.00**			
Corn oil/Fish oil	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**	**5.00**
Tallow	2.50	2.50	2.50	2.50	2.50	2.50
Wheat	15.00	15.00	15.00	15.00	15.00	15.00
L-Lysine·HCl		0.30	0.43	0.37	0.26	0.04
DL-Methionine	0.13	0.14	0.11	0.15	0.11	0.04
L-Threonine			0.02	0.02		
L-Tryptophan	0.05	0.15	0.16	0.24	0.12	
Others	3.45	3.30	3.30	3.94	3.51	3.00

Materials and Methods

- 120 pigs weaned at 3 wk of age
  - 3 pens of 10 pigs per dietary treatment
  - Growth performance data- BW, ADG, ADFI, G:F
- 12 pigs per treatment
  - Vaccinated against
    - Ovalbumin (OVA) - extracellular antigen
    - *Candida albicans* (CAA) - intracellular antigen
  - Antibody-mediated immune response (AMIR)
    - Serum IgG1 and IgG2
  - Cell-mediated immune response (CMIR)
    - % change in skin fold thickness (SFT)

Protein Quality - BW and ADG

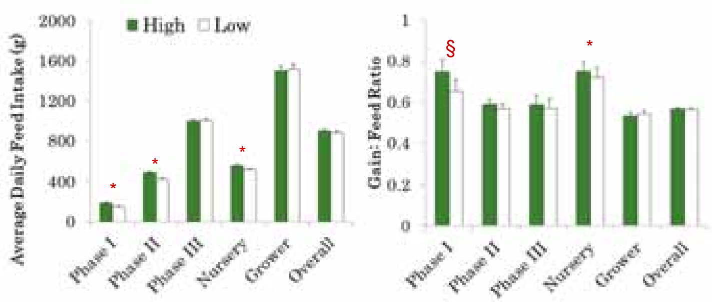


*$P < 0.05$

Phase I, 0-7 d
Phase II, 8-21 d
Phase III, 22-42 d
Nursery, 0-42 d
Grower, 43-56 d
Overall, 0-56 d

Growth performance was affected by diet protein quality only during phase I & II

Protein Quality - ADFI and G:F

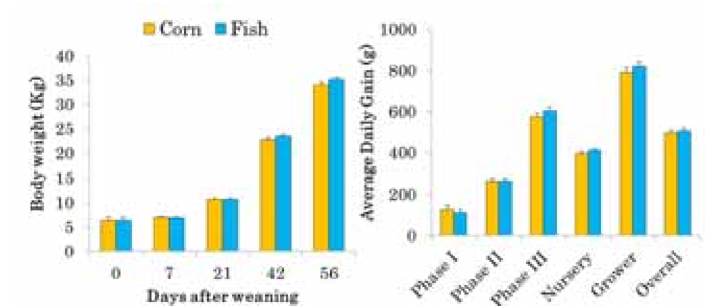


*P < 0.05
§P < 0.10

Phase I, 0-7 d
Phase II, 8-21 d
Phase III, 22-42 d
Nursery, 0-42 d
Grower, 43-56 d
Overall, 0-56 d

Feed intake & G:F affected by protein quality only during early nursery phase

Oil - BW and ADG

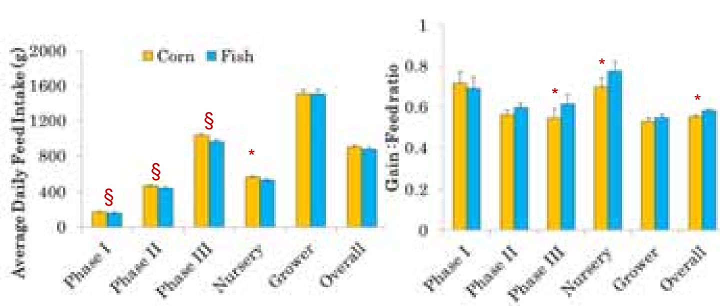


P > 0.10

Phase I, 0-7 d
Phase II, 8-21 d
Phase III, 22-42 d
Nursery, 0-42 d
Grower, 43-56 d
Overall, 0-56 d

No effect of oil on growth performance

Oil- ADFI and G:F

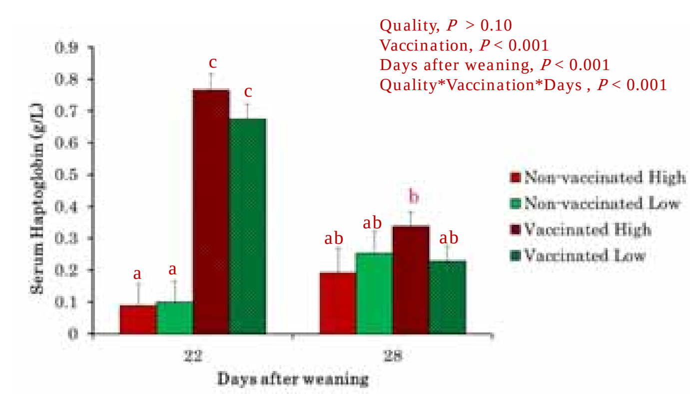


*P < 0.05
§P < 0.10

Phase I, 0-7 d
Phase II, 8-21 d
Phase III, 22-42 d
Nursery, 0-42 d
Grower, 43-56 d
Overall, 0-56 d

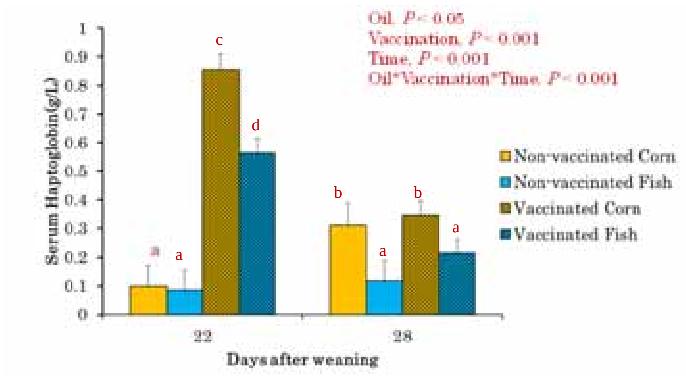
Fish oil improved nursery and overall Gain:Feed

Protein Quality – Serum Haptoglobin



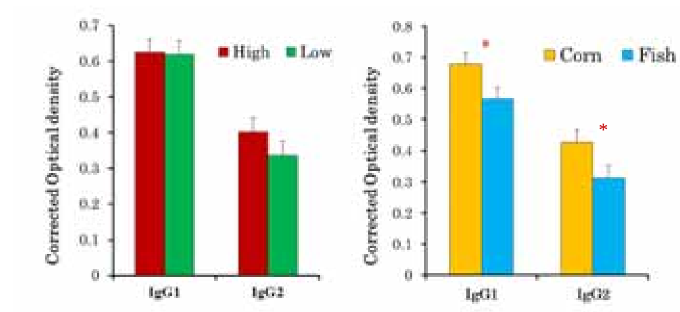
Vaccination protocol induced acute phase response
No effect of nursery diet protein quality on serum haptoglobin

Oil- Serum Haptoglobin



Fish oil attenuated serum haptoglobin levels in both vaccinated and non-vaccinated pigs

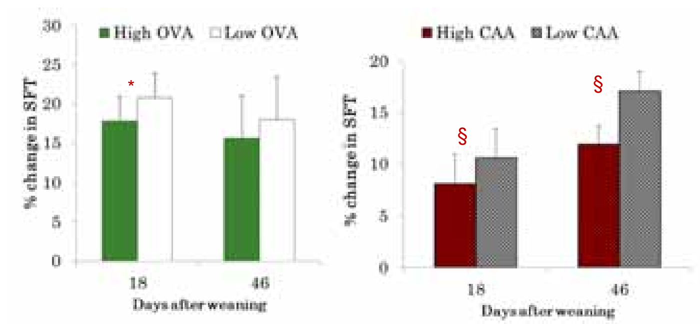
AMIR – IgG1 and IgG2



*P < 0.05

Pigs fed fish oil had lower IgG1 and IgG2 than pigs that had corn oil.

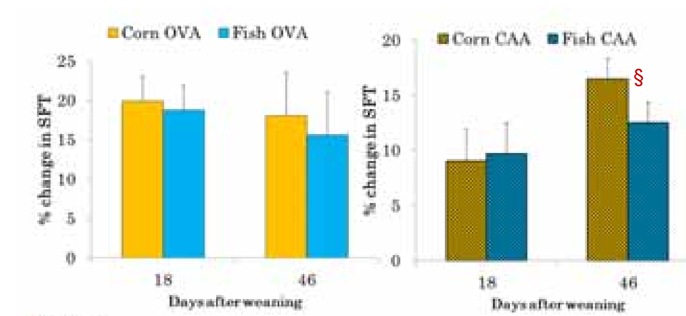
Protein Quality - CMIR



*P < 0.05
§P < 0.10

Nursery diet protein quality had effect on CMIR to both antigens (OVA and CAA)

Oil - CMIR



§P < 0.10

Fish oil lowered CMIR to CAA only

Summary (1/2)

- Nursery diet protein quality is critical during the early nursery phase (Phase I & II) to stimulate feed intake and growth
- Reducing nursery diet protein quality does not impact long-term pig growth performance
- Fish oil improved nursery and overall Gain: Feed

Summary (2/2)

- Fish oil seems to affect immune response more than nursery diet protein quality
  - Fish oil attenuated host acute phase immune response
    - Antibody mediated (IgG1 and IgG2)
    - Cell mediated (skin fold thickness)
- Diet represents various opportunities to influence the pigs immune response

Conclusions & Implications

- No impact of nursery diet complexity on wean-to-finish growth performance or carcass value
  - Reduced nursery feed costs creates opportunity for increased profits
- Interactions between nursery diet complexity and immune response – during a severe disease challenge - requires further exploring
  - May be mediated through long-term changes in gut micro-flora and expression of genes involved in the immune response
  - Focus on immuno-nutrition (fatty acids, amino acidd; bioactive peptides) & pig genotype x environment interactions

Novel Feeding Strategies for the Growing pig:
Simple vs Complex Nursery diets

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