Evaluation of a microbially-converted soybean meal as a substitute for fishmeal in nursery pig diets

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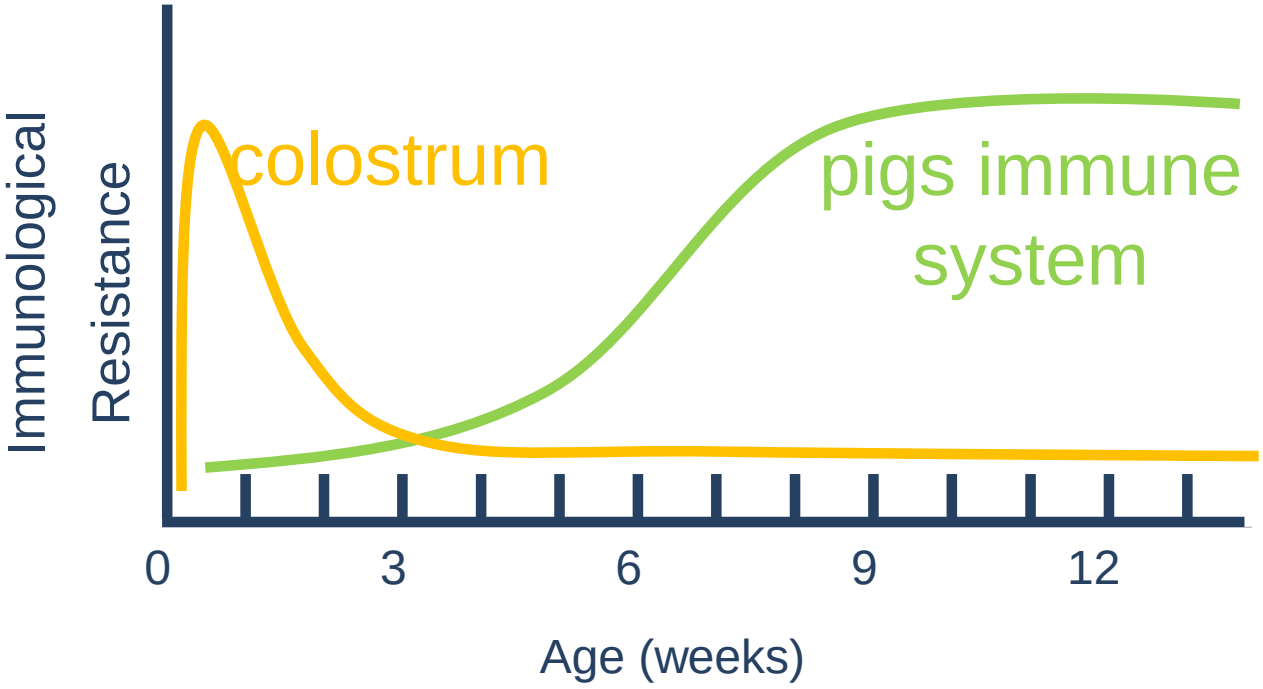
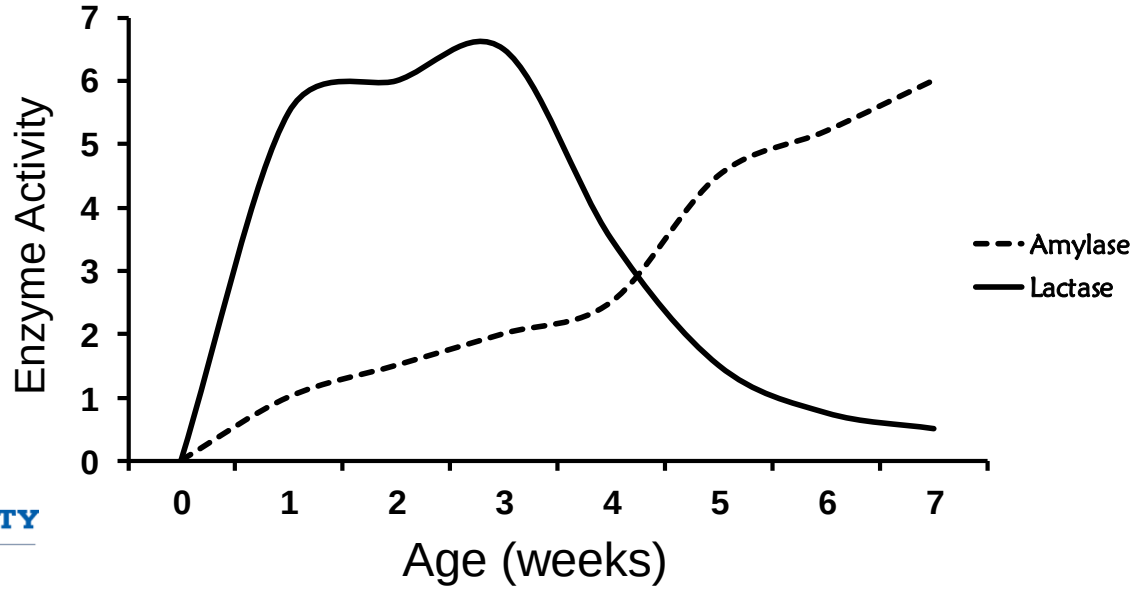
Importance of high quality ingredients for nursery pigs

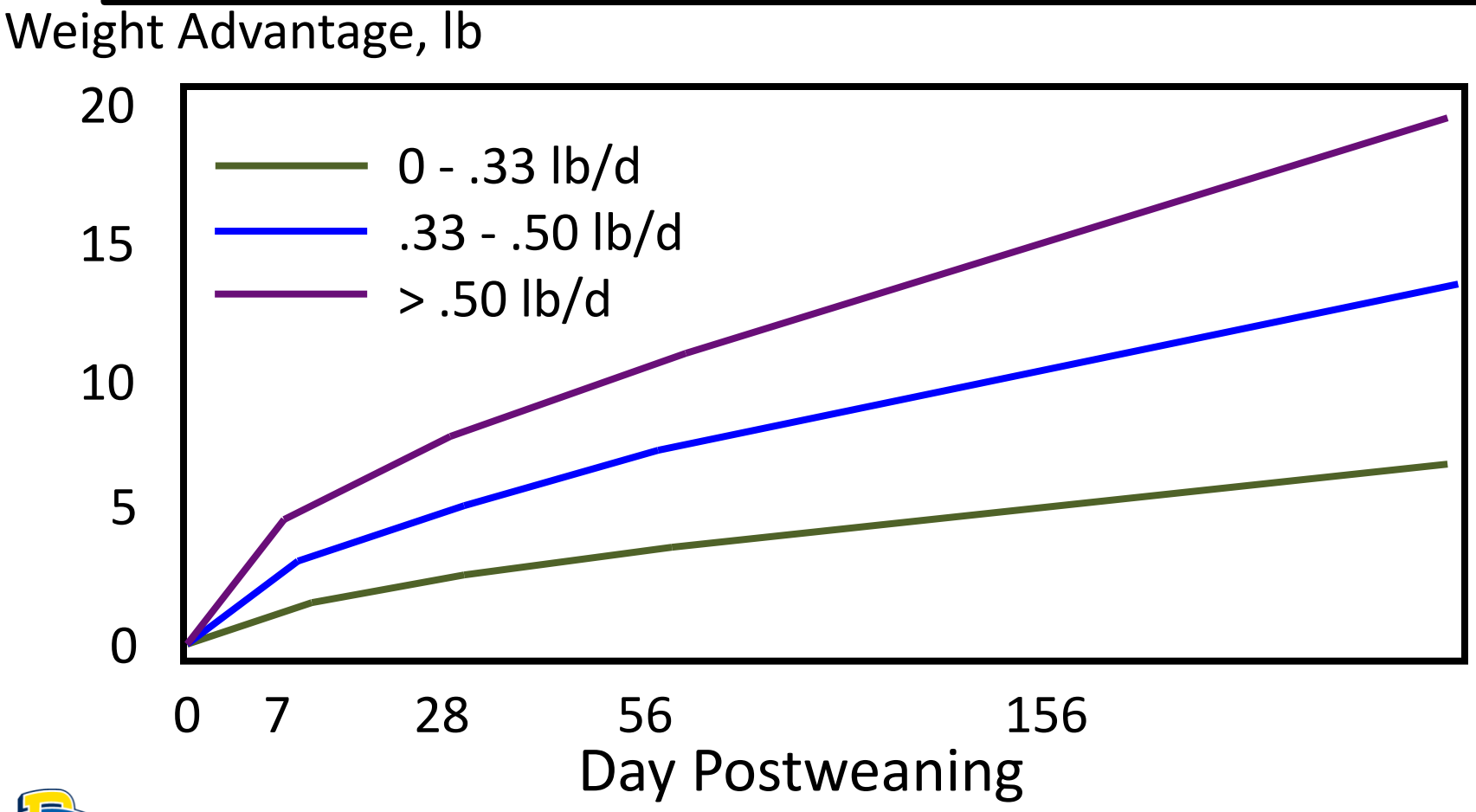
- Physiological need
  - Digestive enzyme development (starch, fat)
  - Developing immune system
  - Low feed intake
  - High growth rate potential


Immunological Resistance
colostrum
pigs immune system
0
3
6
9
12
Age (weeks)


Enzyme Activity
0
1
2
3
4
5
6
7
Age (weeks)
Amylase
Lactase

Influence of Growth During the First Week Post Weaning

Compensatory growth unlikely to make up for slow growth in first week



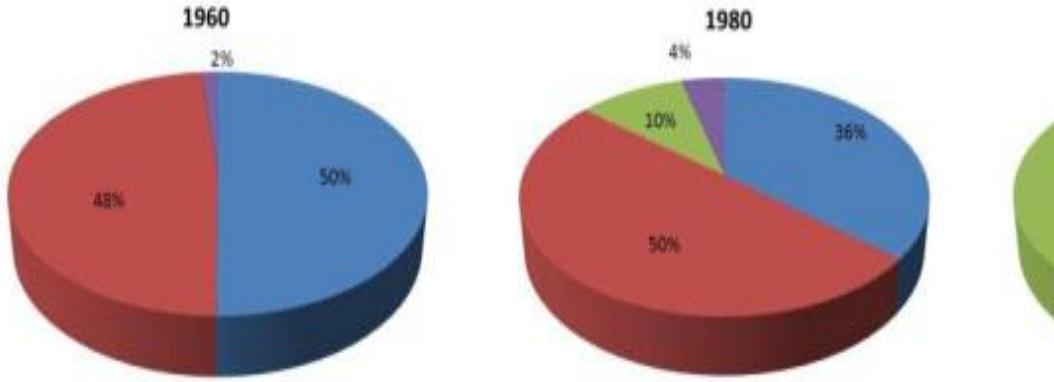
Tokach et al., 1992

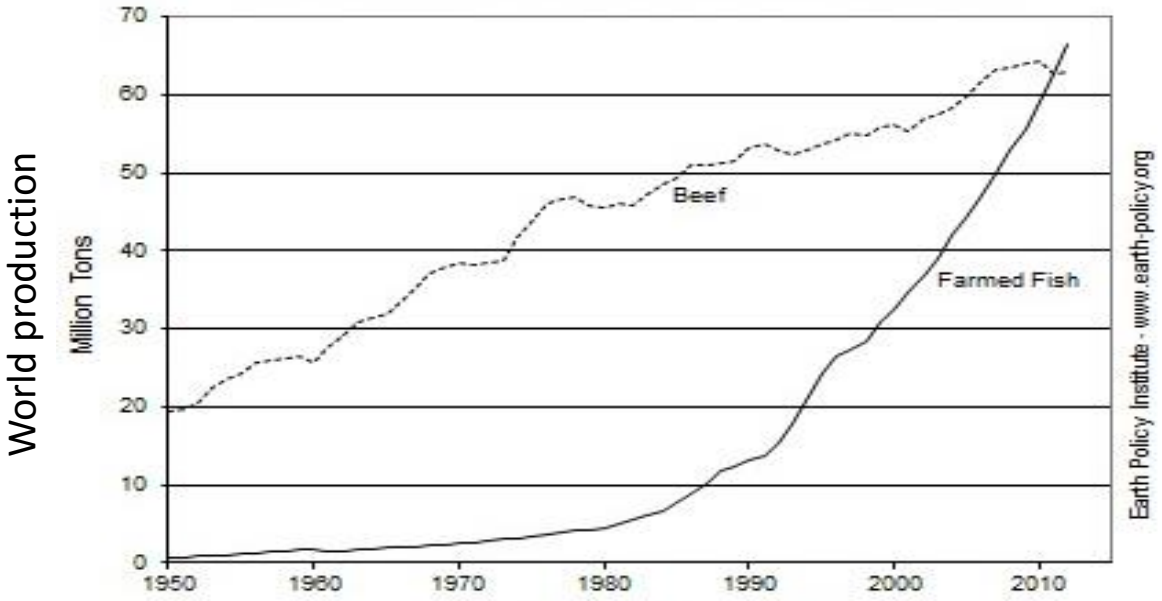
Fishmeal and nursery pigs

- Early weaning was facilitated by the use of nutrient dense, high quality protein sources
  - Fishmeal
    - 65% protein, 4.5% Lys, few anti-nutritional factors or fiber
  - Recommend 5 – 7.5% inclusion for first 7d
    - dependent on herd disease status to optimize gains and feed costs

Stoner et al., 1990; Bergström et al., 1997

Increasing demand for fishmeal





Source: IFFO Positional Statement. 2013. Is aquaculture growth putting pressure on feed fish stocks? Source: Earth Policy Institute. 2013. EPI based on FAO, USDA.

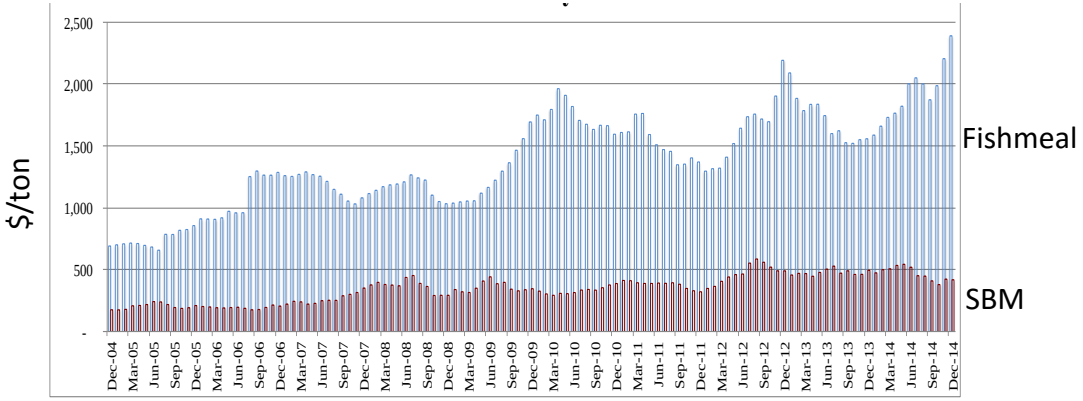
Plasma proteins

- Positives
  - High quality protein source with complementary AA profile
  - Stimulates feed intake
  - Reduces intestinal immune activation, promotes gut health and restoration
- Negatives
  - Cost

Hansen et al., 1993; Bergström et al., 1997; Zhang et al., 2016

Soybean meal conundrum

- Positives
  - Economical relative to other quality protein sources
  - Complementary AA profile to cereal grains
  - Readily available
- Negatives
  - Anti-nutritional factors
    - Trypsin inhibitor, P34 protein, lectins, β-mannans
  - Tolerance must be developed = immune activation



Processed SBM

- Bioprocessing or fermentation of SBM
  - Reduces anti-nutritional factors
  - Some degradation of antigenic proteins
  - Retains complementary AA profile
  - Improved digestibility
  - Cost-effective relative to fishmeal

Song et al., 2010; Sinn et al., 2016

MEPRO - objective

- Compare MEPRO to FM in relation to:
  - AA digestibility and age
  - Nursery pig performance
  - Intestinal health
  - In combination with dietary acidifier

Study 1 – animals and diets

- Digestibility
  - 6 ileal cannulated pigs (65 lbs); 37 nursery pigs (22 lbs)
- Performance and gut health
  - 336 weaned pigs (13.4 ± 1.8 lbs, 21 d of age); 8 pens/diet; 5 wks

	Phase I (0 – 7d postwean)				Phase II (8 – 21d postwean)		
Item, %	Control	+FM	+MEPRO		Control	+FM	MEPRO
Corn	34	40	39		45	51	50
Conventional SBM	37	25	25		41	31	31
Whey	25	25	25		10	10	10
FM/MEPRO		7.5	7.5			5	5

ME = 1,523 kcal/lb; SID Lys = 1.35%

Sinn et al., 2016

Study 1 - observations

- Weekly BW and feed disappearance
- Daily diarrhea assessment (d 0 – 14)
- Intestinal tissue collection (d 7 and 14)
  - Inflammatory cells, proliferation marker, digestive enzyme activity, morphology, pH

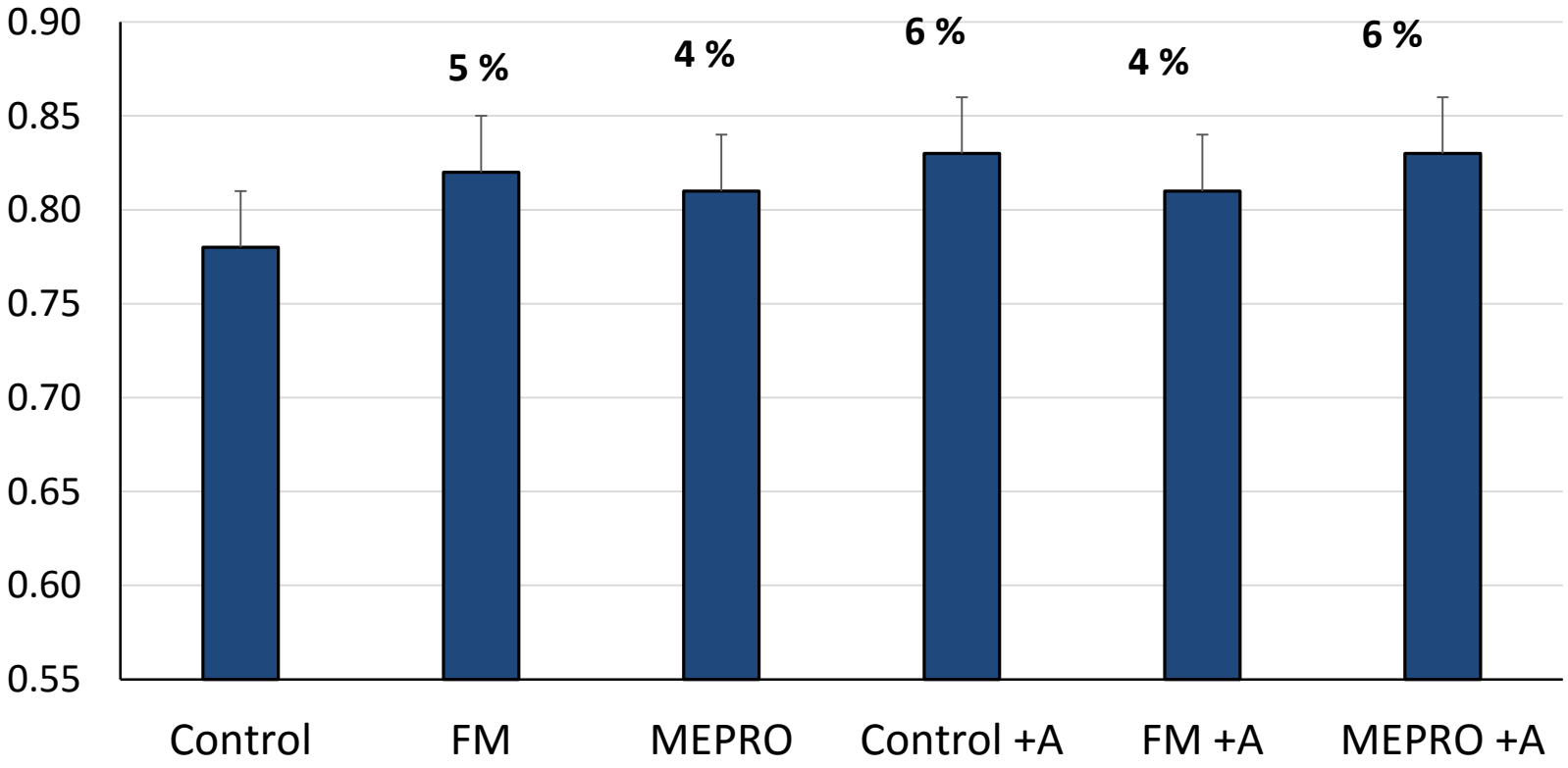
Standard ileal digestibility

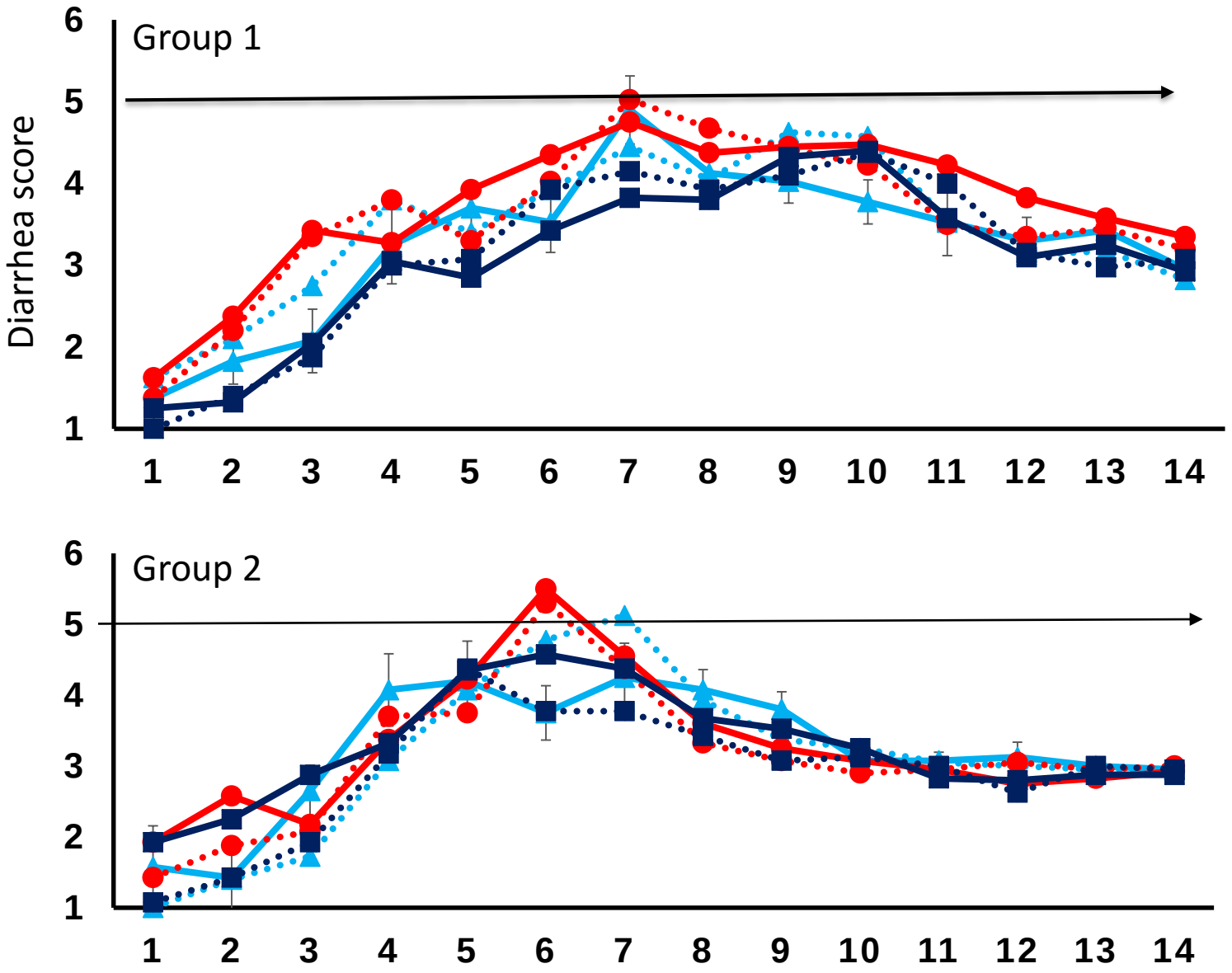
	65 lbs				22 lbs		
AA	FM	MEPRO	SEM		FM	MEPRO	SEM
Lysine	**93.8**	**88.8**	**0.62**		82.0	85.6	1.6
Methionine	**93.8**	**91.0**	**0.58**		**76.7**	**87.0**	**2.9**
Threonine	**92.7**	**88.1**	**0.89**		79.3	77.8	2.7
Leucine	**95.1**	**91.6**	**0.68**		85.1	83.3	1.9
Isoleucine	**94.8**	**91.0**	**0.70**		84.2	83.1	2.0
Valine	92.6	90.4	0.77		81.6	82.5	2.1
Phenylalanine	92.5	90.9	0.66		81.2	83.1	2.4
Histidine	92.0	89.6	0.89		75.7	80.7	2.5

Growth performance

	Control	FM	MEPRO	Control +A	FM +A	MEPRO +A
ADG, lbs/d						
0 – 7 d	0.11	0.13	0.07	0.04	0.11	0.13
8 – 21 d	0.73	0.75	0.75	0.79	0.73	0.77
22 – 35 d	1.54	1.72	1.58	1.65	1.65	1.58
ADF, lbs/d						
0 – 7 d	0.24	0.24	0.24	0.24	0.24	0.26
8 – 21 d	0.97	0.97	0.95	0.95	0.99	0.99
22 – 35 d	1.81	2.00	1.87	1.98	1.98	1.89
BW, 35 d	43.8	44.5	43.3	44.8	44.6	44.8

Gain:feed Phase II





pens treated

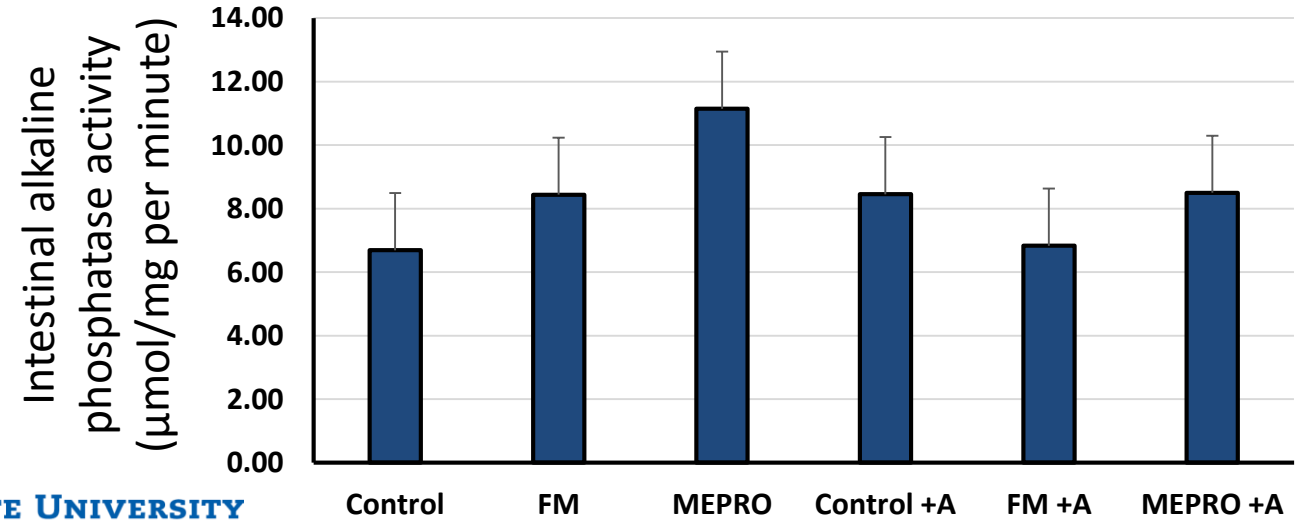
Control – 63 %

FM – 63 %

MEPRO – 50 %

Intestinal health and digestive capacity

Item	Control	FM	MEPRO	Control +A	FM +A	MEPRO +A	SEM
Stomach	4.23	3.56	3.62	3.80	4.01	3.88	0.28
Duodenum	5.12	5.54	5.30	5.38	4.66	5.53	0.31
Jejunum	6.40	6.38	5.93	6.43	6.68	6.19	0.30
Ileum	6.99	6.88	7.00	6.72	7.05	7.02	0.30



Conclusions

- MEPRO is suitable as a replacement for FM
  - Similar digestibility
  - Lesser impact of age on digestibility
  - Impact on gain:feed
  - Reduced diarrhea severity and incidence
    - Intestinal pH/digestive capacity/inflammation

Study 2 - objectives

- Assess MEPRO as an alternative for fishmeal and plasma proteins on nursery pig performance and immune function

Study 2 – animals and diets

- 240 weaned pigs (21 d of age; 14.3 ± 0.7 lbs); 10 pens/trt; 5 wks

Item	Control	MEPRO (-FM)	MEPRO (-SDP)	MEPRO (-FM-SDP)
Corn	42.7 (56.4)	41.1 (54.9)	37.6 (51.3)	34.4 (48.0)
SBM, standard	15.0 (22.0)	15.0 (22.0)	15.0 (22.0)	15.0 (22.0)
Whey	25.0 (10.0)	25.0 (10.0)	25.0 (10.0)	25.0 (10.0)
Fishmeal	7.5 (5.0)	-	7.5 (5.0)	-
Blood plasma	6.5 (3.0)	6.5 (3.0)	-	-
MEPRO	-	7.5 (5.0)	12.0 (8.0)	20.0 (15.0)

Zn 4000 ppm, Phase I; 2000 ppm Phase II

Study 2 - observations

- BW and feed disappearance weekly
- Innate immune response
  - Lymphocyte proliferation
- Adaptive immune response
  - Antibody- and cell-mediated immune response

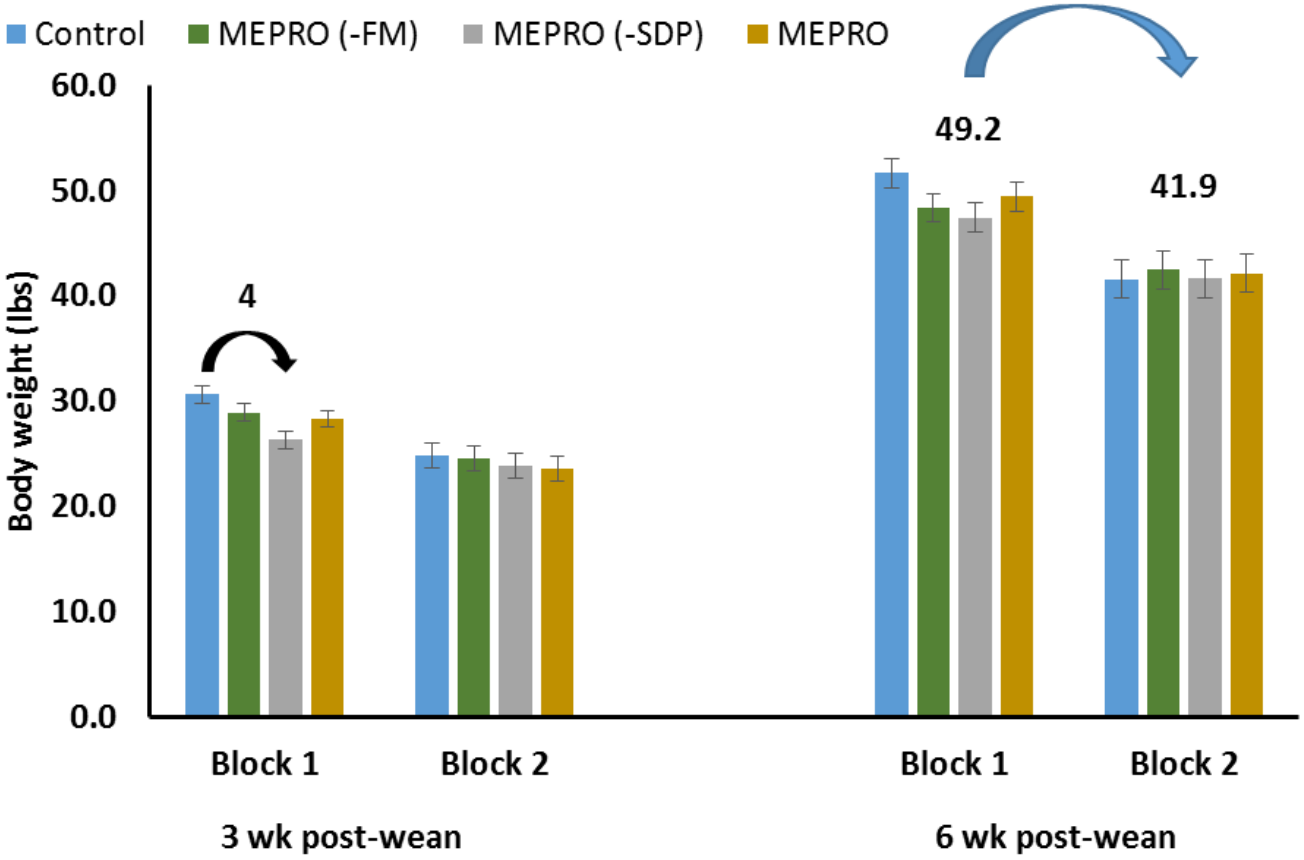
Growth performance

Item	Control	MEPRO (-FM)	MEPRO (-SDP)	MEPRO	SEM
BW, lbs					
Phase I	15.7	14.9	14.3	14.4	0.6
Phase II	27.7^{a}	$26.7^{a,b}$	25.1^{b}	$26.0^{a,b}$	0.7
Phase III	46.6	45.4	44.5	45.8	1.1
ADG, lbs/d					
Phase I	0.134	0.078	-0.013	0.014	0.027
Phase II	0.897^{x}	$0.888^{x,y}$	0.802^{y}	$0.858^{x,y}$	0.028
Phase III	1.329	1.293	1.372	1.404	0.036

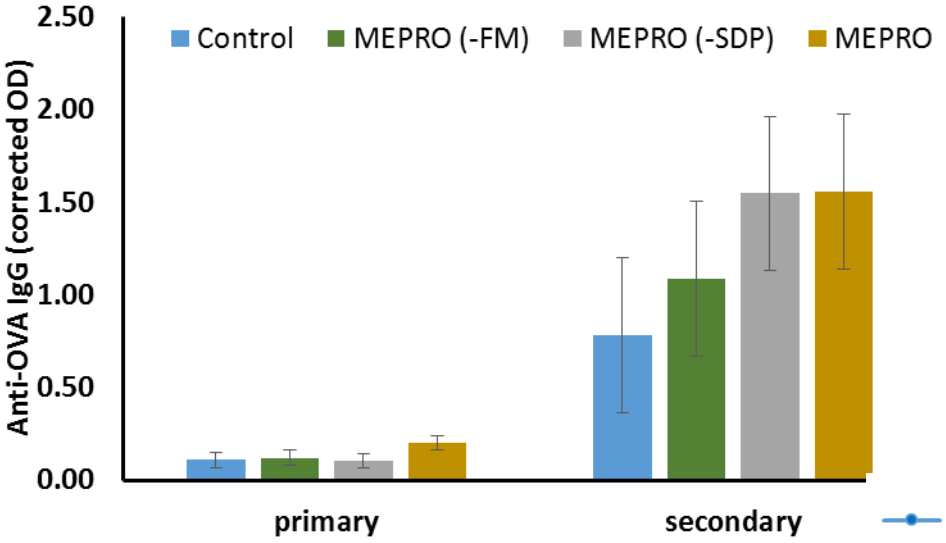
Growth performance

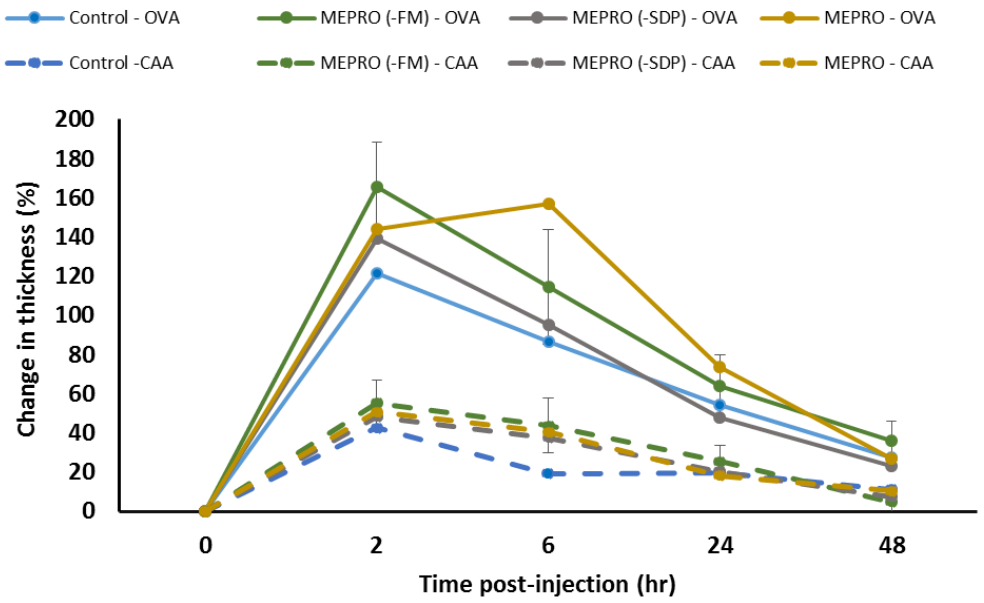
Item	Control	MEPRO (-FM)	MEPRO (-SDP)	MEPRO	SEM
ADF, lbs/d					
Phase I	0.267	0.233	0.221	0.231	0.014
Phase II	1.117	1.073	1.010	1.111	0.035
Phase III	2.016	2.022	2.090	2.097	0.079
Gain:feed					
Phase I	0.274	0.016	-0.841	-0.190	0.272
Phase II	$0.802^{a,b}$	0.827^{a}	$0.795^{a,b}$	0.767^{b}	0.015
Phase III	0.658	0.639	0.669	0.676	0.025

The impact of subclinical health and week 1 performance



Enhanced adaptive immunity





Conclusions

- MEPRO suitable to replace fishmeal and spray dried plasma based on performance
  - Alter immune system to enhance adaptive immune response
  - Ingredient interaction (FM and MEPRO)

Other published evidence

- Growth performance – nursery pigs
  - Improved daily gain and feed intake (Min et al., 2004)
  - Improved gain and feed efficiency when included with porcine solubles but not alone or in combination with FM (Jones et al., 2010)
  - Reduced diarrhea score (Song et al., 2010)

- Understanding biological mechanisms beyond pig growth to allow development of products with greater consistency in multiple environmental settings

Acknowledgements

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