Animal Co-Products in Swine Nutrition

The FPRF INNOVATE CONFERENCE

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Animal Protein Products

- One-third to one-half of the weight of food production animals is not consumed by humans.
- Primary products: Meat and bone meal, meat meal, poultry meal, hydrolyzed feather meal, blood meal, fish meal, and animal fats.
- The primary products of rendering are feed ingredients for livestock, poultry, aquaculture, and pet-food industries.

- **Least cost formulation (LCF) constraints**
  - **Energy**
  - **Selected amino acids**
  - **Ca, P**
- **Further considerations of LCF:**
  - **Digestibility of amino acids**
  - **Digestibility of phosphorus / phytase**
  - **Mins/maxs of nutrients and ingredients**

World Protein Meal Consumption

Protein Source	Millions Metric Tons	Percent
Soybean meal	114.9	67
Cottonseed meal	11.2	6
Rapeseed meal	21.4	12
Sunflower meal	9.6	5
Copra meal	1.8	1
Palm kernel meal	3.6	2
Peanut meal	5.4	3
Fish meal	6.1	4
Total	173.9	100

Soy Stats (2001)

CP, AA, Ca and P (%) of rendered meat products compared to SBM

Component	Soybean meal	Meat and bone meal	Meat meal	Poultry Meal	Plasma meal (Spray dried)
DM	89.98	95.16	96.12	96.2	91.97
Protein	47.73	50.05	56.40	64.72	77.84
Lysine	2.96	2.59	3.20	3.99	6.90
Threonine	1.86	1.63	0.40	2.55	4.47
Methionine	0.66	0.69	0.83	1.15	0.79
Cysteine	0.70	0.46	0.56	0.87	2.60
Tryp	0.66	0.30	1.89	0.62	1.41
Isoleucine	2.14	1.47	1.82	2.50	2.69
Valine	2.23	2.19	2.61	3.07	5.12
Ca	0.33	10.94	6.37	2.82	0.13
P	0.71	5.26	3.16	1.94	1.28

NRC (2012)

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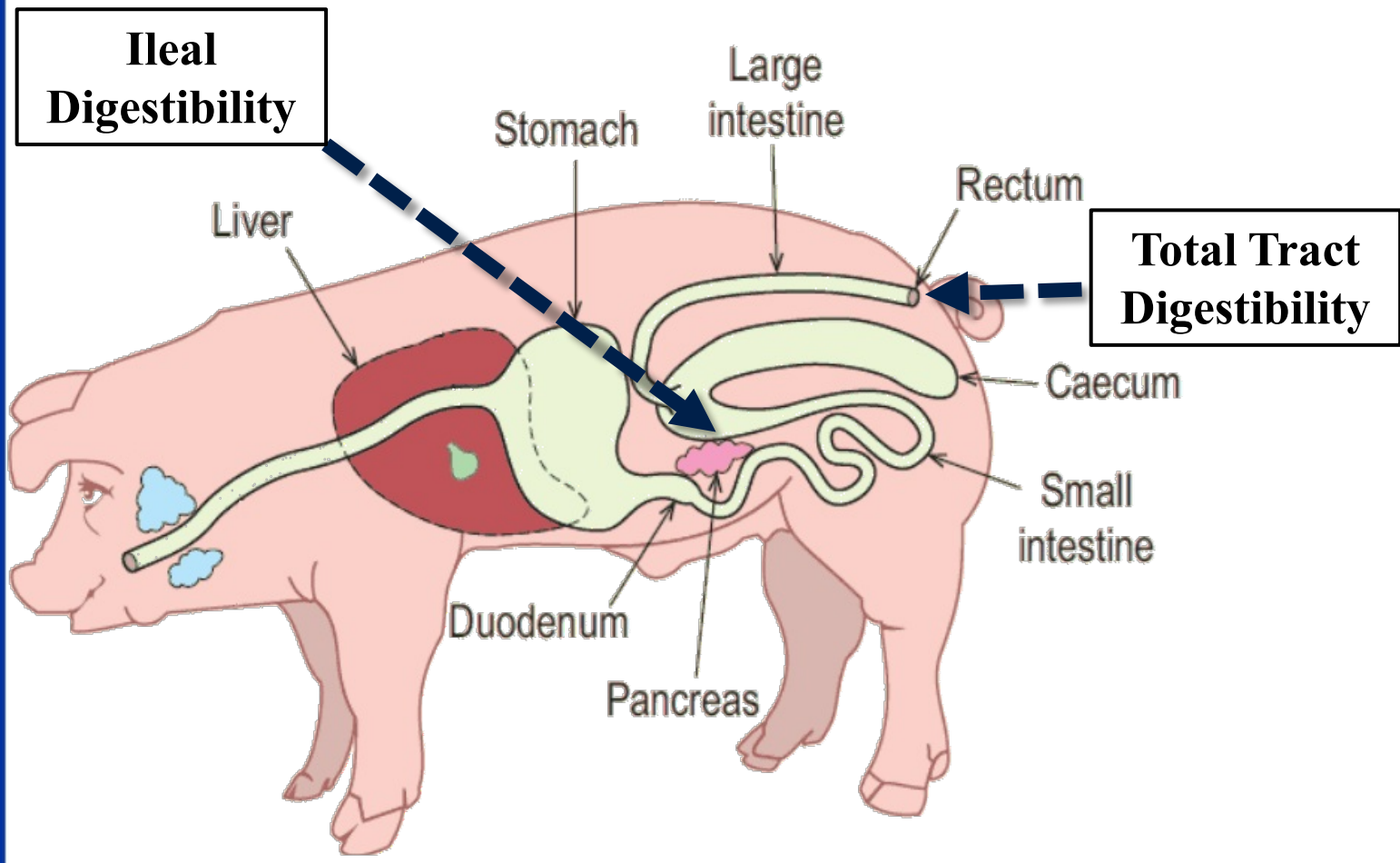
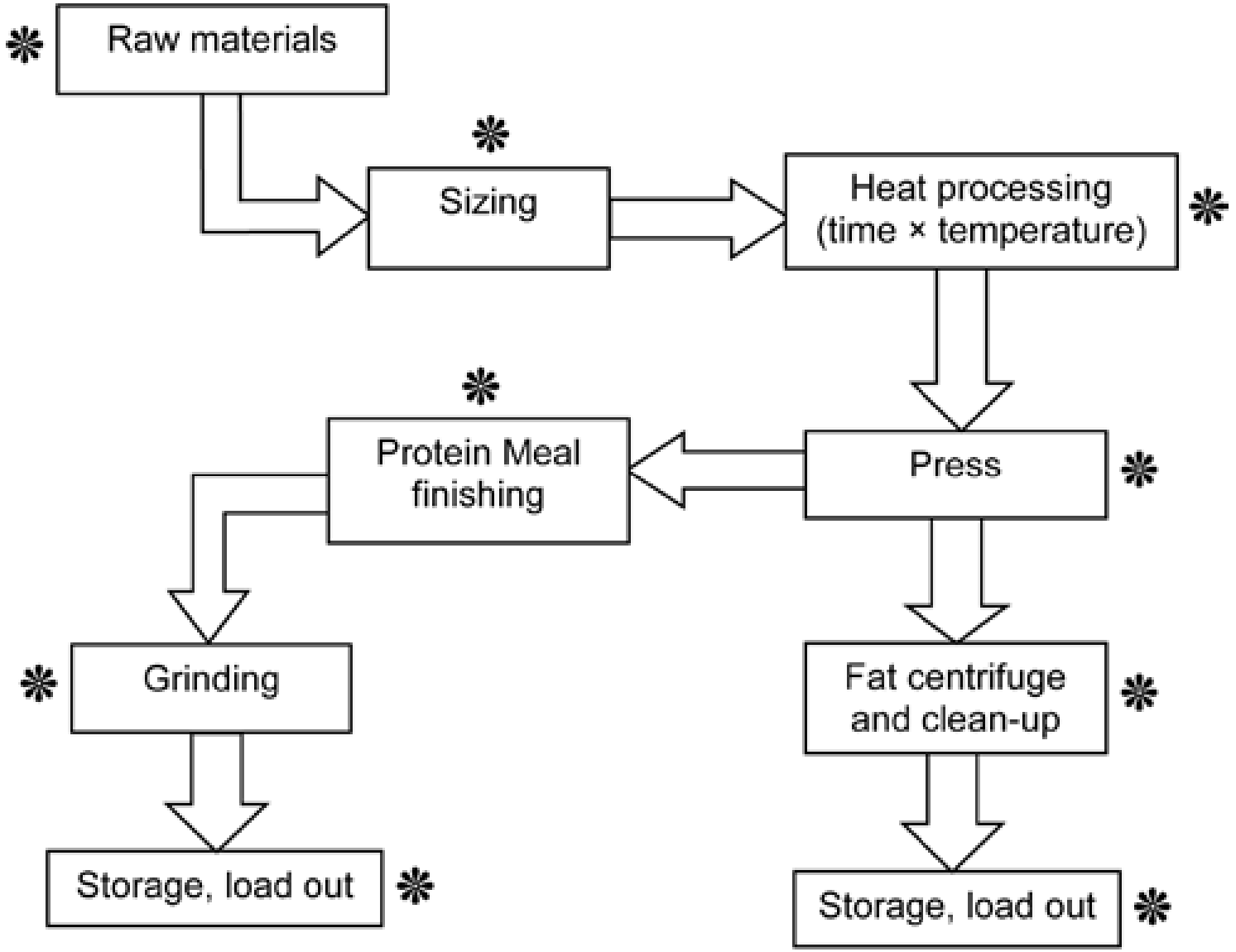
Nutrient digestibility for pigs



Digestibility (%) of selected AA in MBM from 1984 to 2001

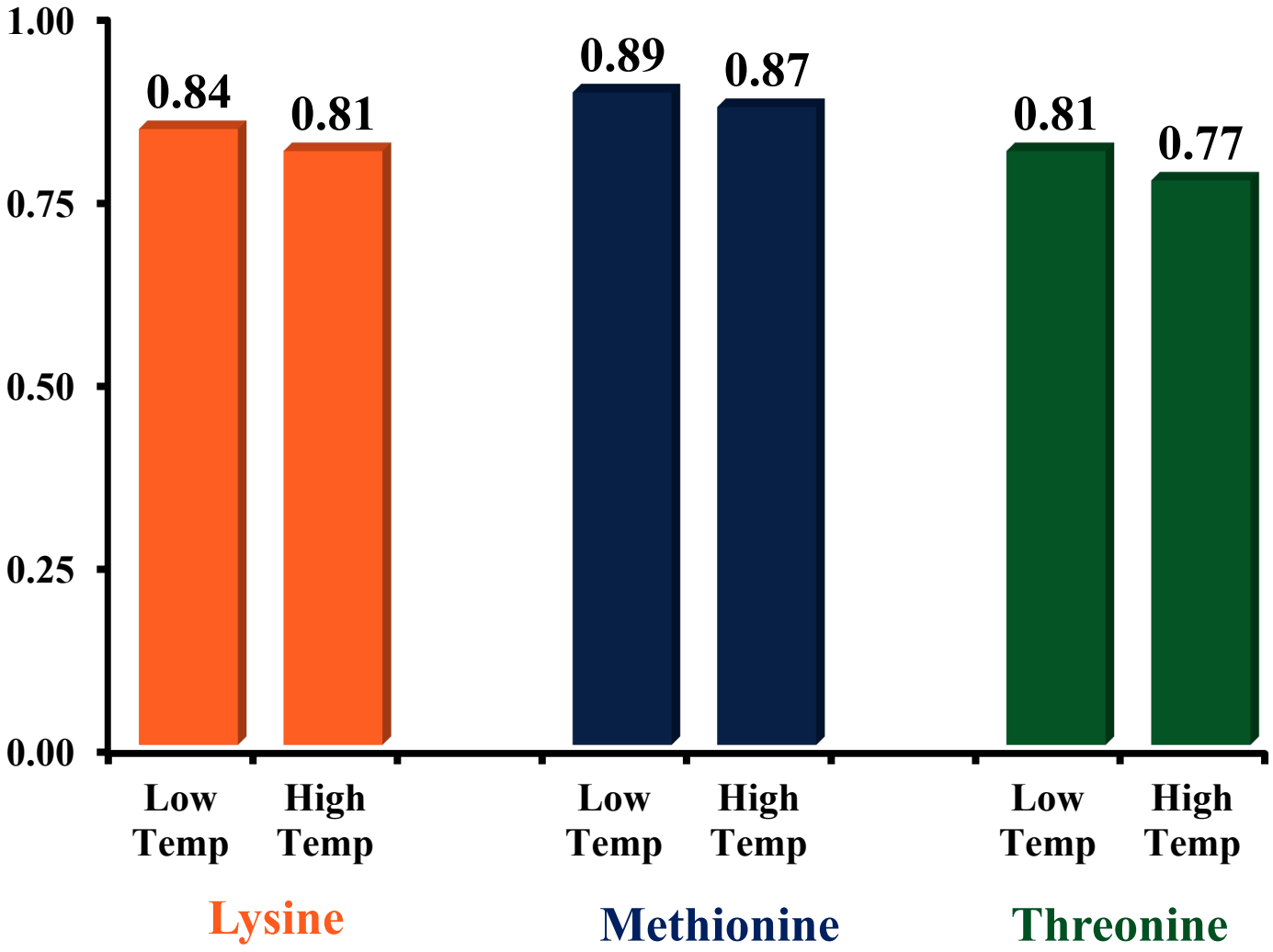
Amino acid	1984	1989	1990	1992	2001
Lysine, %	65	70	78	84	87
Threonine, %	62	64	72	83	86
Tryptophan, %	–	54	65	83	88
Methionine, %	82	–	86	85	88

Meeker and Meisinger (2015)



Meeker and Hamilton, 2006.

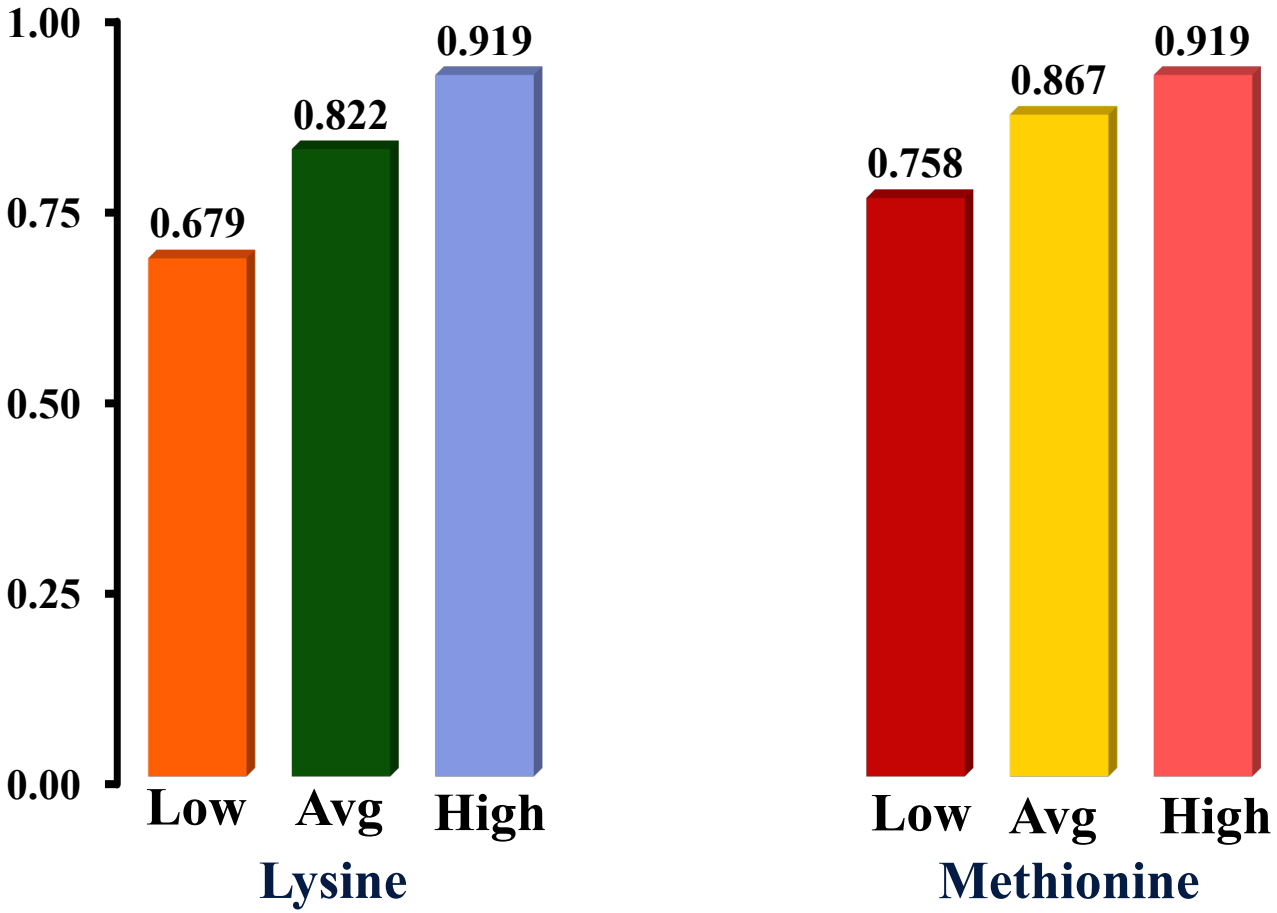
Effects of Temperature on AA Digestibility



Wang and Parsons (1998) from Dozier (2015)

True AA Digestibility

32 Commercial Meat and Bone Meal Samples



Wang and Parsons (1998) from Dozier (2015)

AA digestibility (%) in pigs of selected rendered proteins and SBM

Amino acid	SBM	MBM	Meat meal	Poultry meal	Plasma meal (Spray dried)
Lysine	89	73	78	-	87
Threonine	85	69	74	-	80
Methionine	90	84	82	-	84
Cysteine	84	56	62	-	85
Tryptophan	91	62	76	-	92
Isoleucine	89	73	78	-	85
Valine	87	76	76	-	82

NRC (2012)

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  - **Ca, P**
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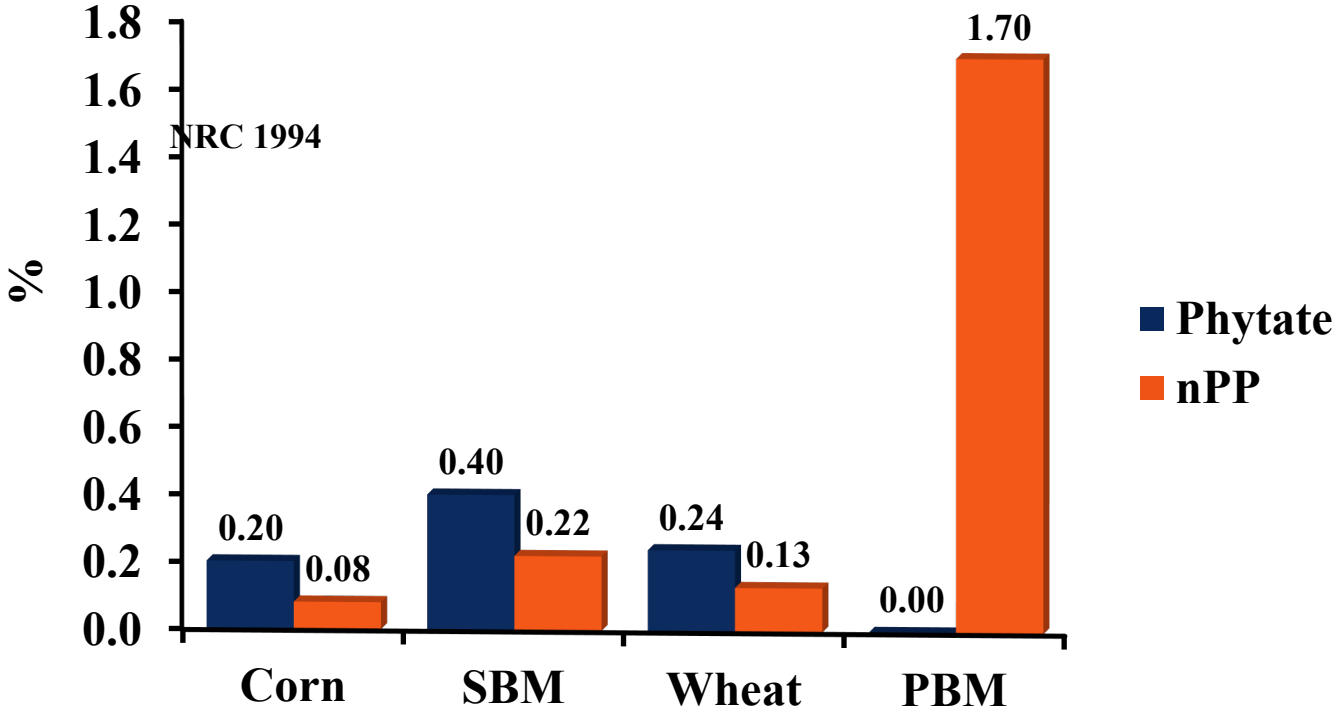
  - **Digestibility of amino acids**
  - **Digestibility of phosphorus / phytase**
  - **Mins/maxs of nutrients and ingredients**

Feeding P to Animals

- **All plant and animal feed ingredients have P**
  - **Non-phytate phosphorus (nPP)**
  - **Phytate phosphorus**



From Dozier (2015)

- **Least cost formulation (LCF) constraints**
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Basic tastes

- **Sweet**
- **Sour**
- **Salty**
- **Bitter**
- **Savory (umami; described as brothy or meaty)**

Spray Dried Porcine Plasma (SDPP)

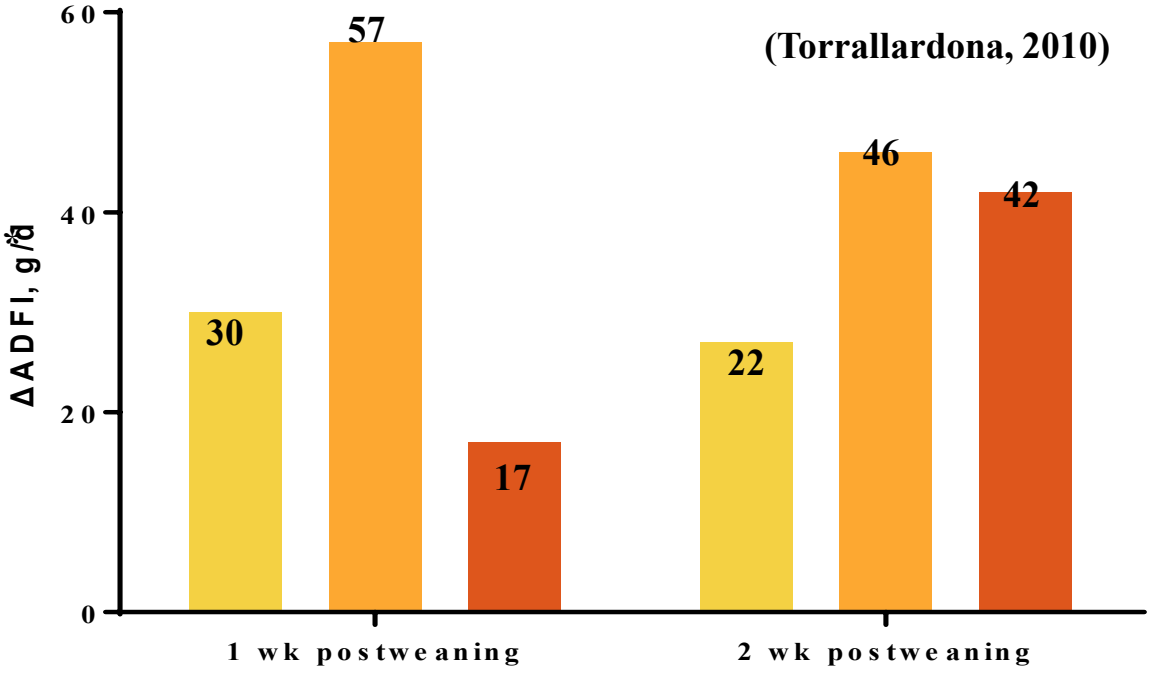
- By-product of meat packing industry
- Improve growth performance of weanling pigs
  - High concentrations of lysine, tryptophan, and threonine
  - Enhance dietary palatability
  - Maintain intestinal health through immunoglobulins
- Expensive

Item	Daily gain	Daily feed intake	Feed/gain
No. of experiments	79	79	79
No. with positive response	70	70	42
% with positive response	89	89	53
% of overall response	25	21	4

- Summary of 79 experiments (8,448 pigs) weaned at an average of 19.7 days of age and averaging 5.8 kg.
- Average test period was 15 days. Average level of plasma in diets was 7%.

(Coffey and Cromwell, 2001)

Effects of spray dried porcine plasma (SDPP) on feed intake of weanling pigs



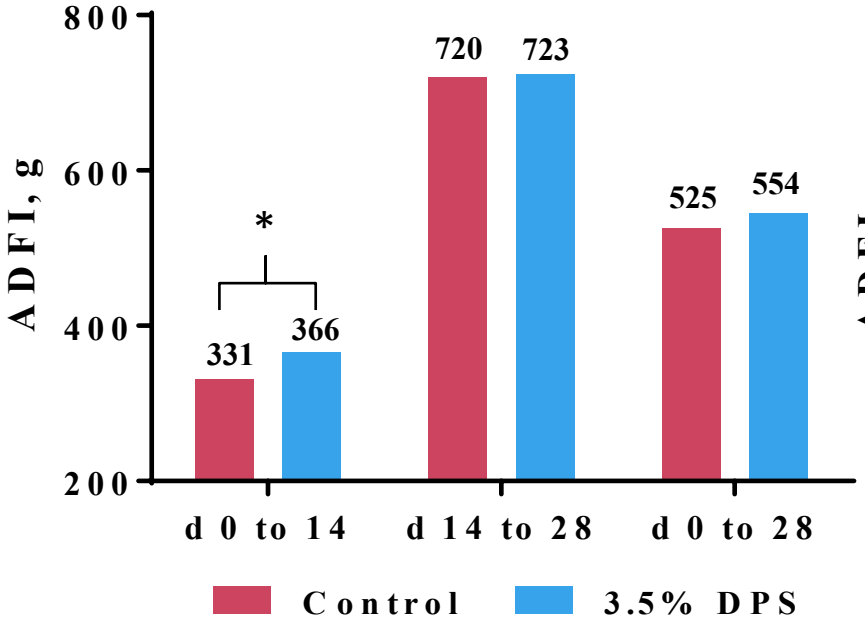
*ΔADFI: ADFI improvement of SPDD diets over control diets
Data from 75 trials involving over 12,000 piglets

Weaning age

10 to 17 d 18 to 24 d 25 to 32 d

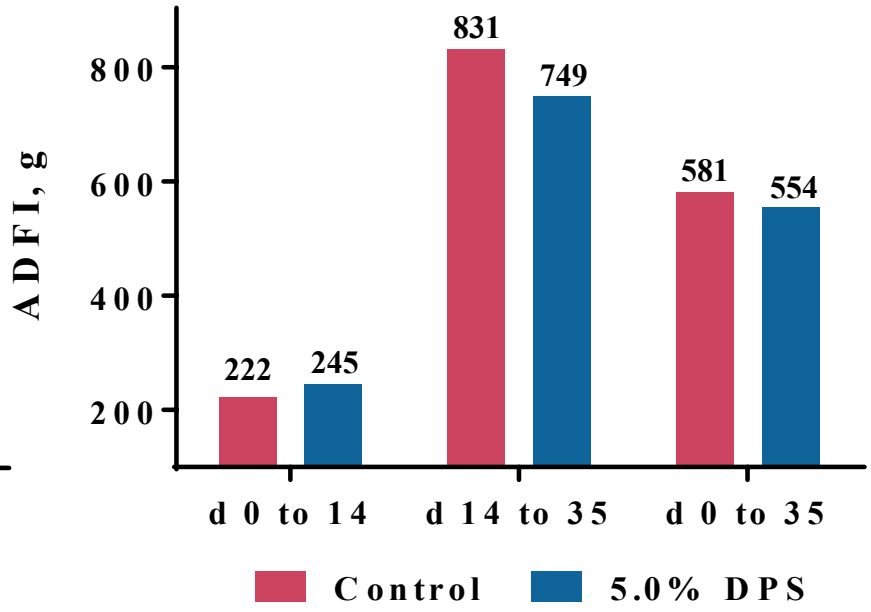
Dried Porcine Solubles (DPS)

- DPS is a by-product of the heparin extraction from pig intestines
- Control pigs were fed corn-SBM-dried whey based diets without DPS



- Weaned at d 21

(Jones et al., 2010)

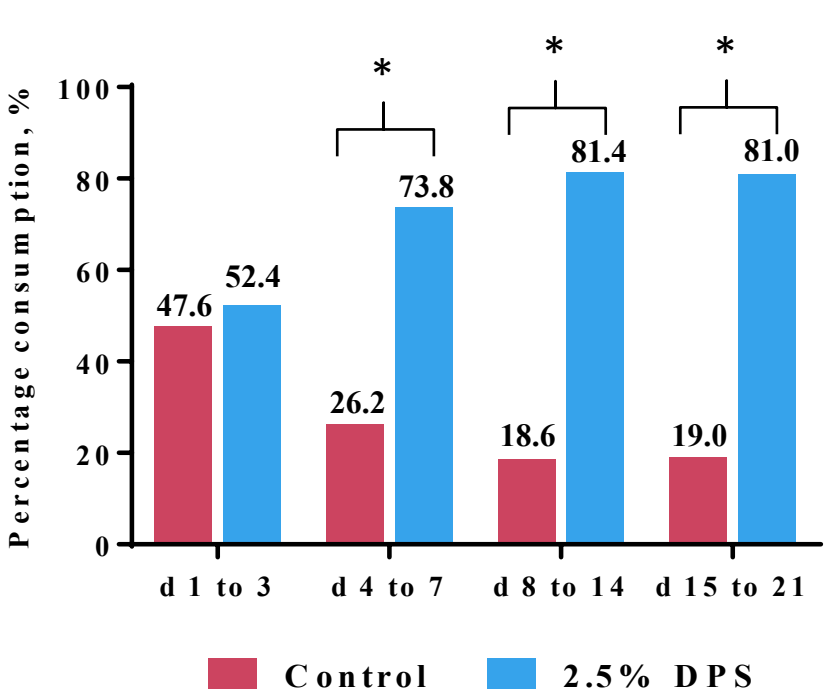


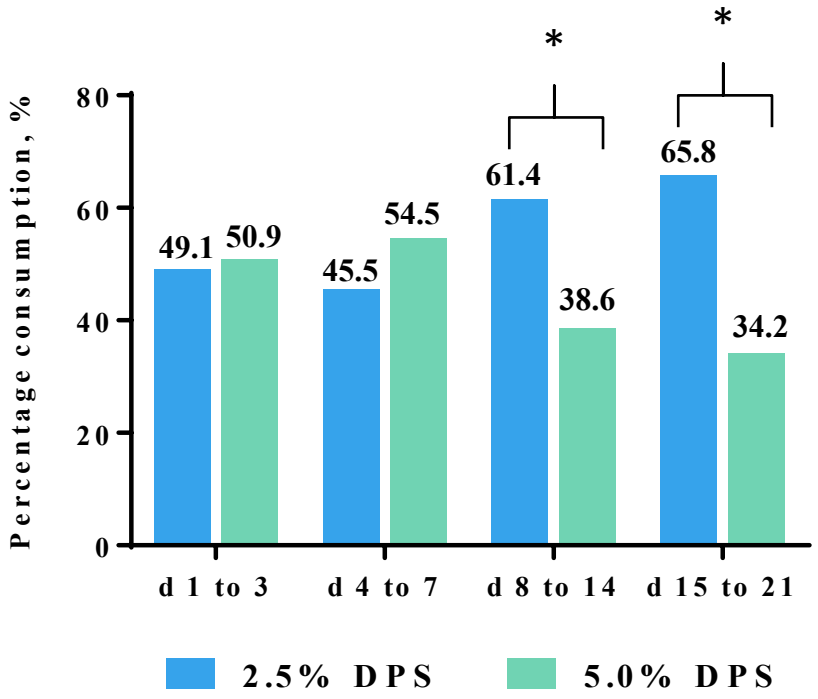
- Weaned at d 11 to 14

(Bregendahl et al., 1999)

Effects of dried porcine solubles (DPS) on feed preference of weanling pigs

- Preference test
- Two feeders per pen, rotate feeder location 3x/week

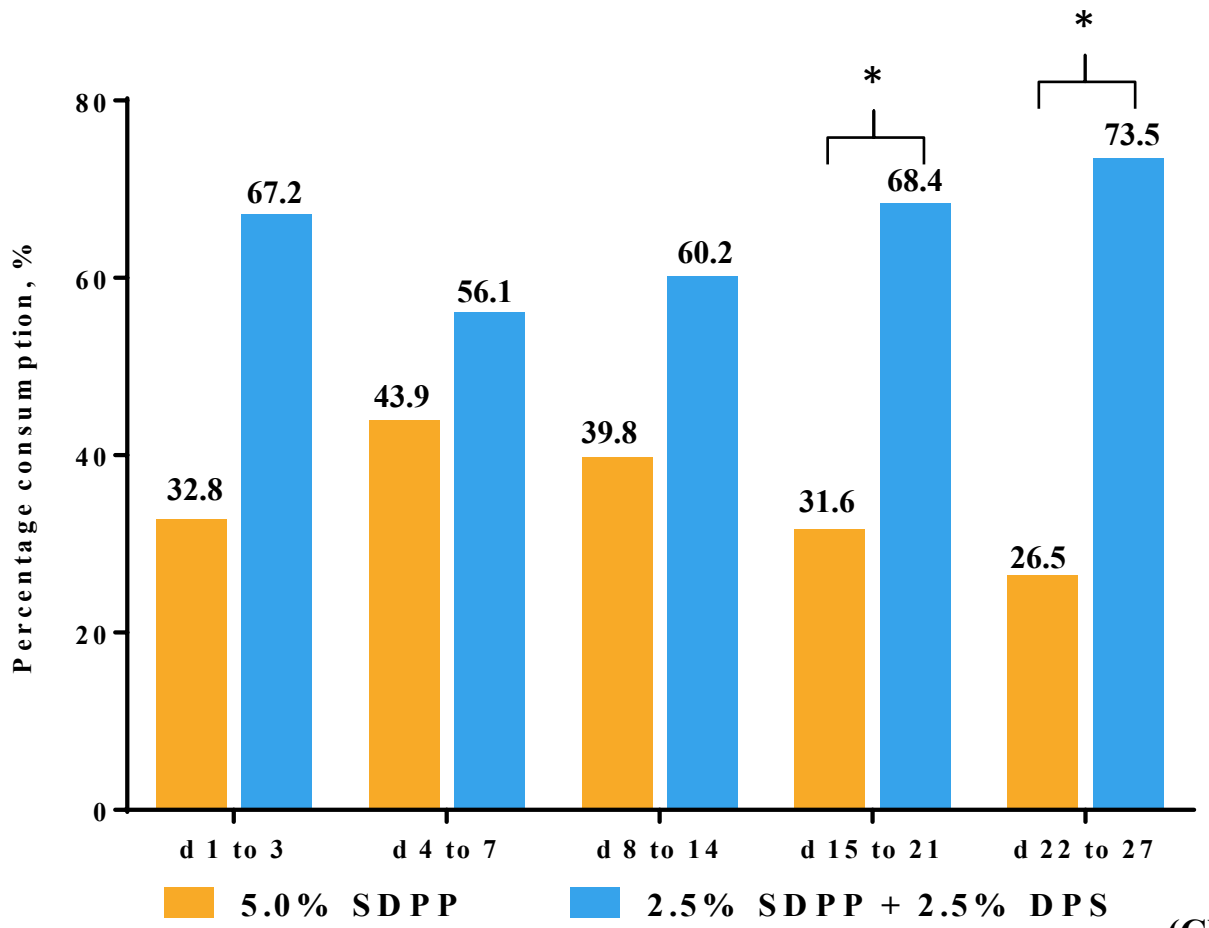




(Cho et al., 2010)

Effects of dried porcine solubles (DPS) on feed preference of weanling pigs

- Potential alternative to SDPP



(Cho et al., 2010)

Bioavailability of phosphorus in meat and bone meal for swine

Traylor, Cromwell, and Lindemann
JAS 83:1054-1061. 2005

Bioavailability of P in MBM, relative to that of MSP, is high (approximately 91%) for growing pigs, and MBM can serve as the sole source of supplemental P and Ca for finishing pigs.

Effects of particle size, ash content, and processing pressure on bioavailability of phosphorus in meat and bone meal for swine

Traylor, Cromwell, and Lindemann

JAS 83:2554-2563. 2005

Fineness of grind of MBM or processing pressure did not influence the relative bioavailability of P; however, ash content of MBM affected P bioavailability. The relative availability of P in low-ash MBM of porcine origin (with composition typical of meat meal) was approximately 15 percentage units less than that in high-ash MBM of bovine origin.

Preference of pigs for various sources of rendered animal protein byproducts

Merlin D. Lindemann

Final report submitted August 2021

Introduction

- **Animal byproducts**
  - **Priced-out** in least cost diet formulation programs (cost-competition with soybean meal)
- **Spray-dried plasma protein (SDPP)**
  - **Expensive** but included in young pig diets due to **increased feed intake** and consequently, **growth rate**
- **Mammalian taste receptors**
  - Sweet, sour, salty, bitter, and **umami** ("meaty" flavor) tastes

Yamaguchi and Ninomiya, 2000. J. Nutr. 130:921S-926S

• Objectives

- Evaluate the effect of feeding graded levels of **poultry byproduct meal** and **meat and bone meal** on **performance** and **feed preference** of **late nursery pigs**.

- Investigate the feed preference of late nursery pigs fed the **best level of each animal protein byproduct-based diets** relative to pigs fed diets containing **conventional SDPP** as verification of the preference effect and as a **potential alternative for SDPP**.

- Investigate graded levels of PBM and MBM in **grower pigs**.

Materials and Methods

- **Experimental procedure (nursery performance)**

- **120 crossbred (**60 barrows and 60 gilts) [(Yorkshire× Landrace) × Large White] with an **initial BW = 15.8 ± 1.3 lbs**

- Allotted to 1 of 5 treatments (**0, 1.5, 3.0, 4.5, or 6.0% PBM**)

- 2 dietary phases
  - **Phase 1** (7 to 11 kg) for 13 d
  - **Phase 2** (11 to 25 kg) for 15 d

- Body weight and feed consumption of pigs were recorded weekly for determination of **average daily gain (ADG)**, **average daily feed intake (ADFI)**, **gain to feed ratio (G:F)**, and **feed to gain ratio (F:G)**.

- **Experimental procedure (nursery preference)**

- **60 crossbred (**36 barrows and 24 gilts) [(Yorkshire× Landrace) × Large White] with an **initial BW = 14.8 ± 3.1 lbs**

- Allotted to 1 of 3 treatments:

  Comparison 1) **0% PBM vs. 3% PBM**,

  Comparison 2) **0% SDPP vs. 3% SDPP**, and

  Comparison 3) **3% PBM vs. 3% SDPP**

- Two feeders were placed in each pen and the location of the feeders switched **3 times/week (each Monday, Wednesday, and Friday)** to avoid the potential of feeder location being confounded with potential feed preference exhibited.

- **Experimental procedure (grower performance)**

- **120 crossbred (**60 barrows and 60 gilts) [(Yorkshire× Landrace) × Large White] with an **initial BW = 57.1 ± 4.6 lbs** for a **42-d performance study.**

- Allotted to 1 of 5 treatments (**0, 1.5, 3.0, 4.5, or 6.0% PBM**)

- Body weight and feed consumption of pigs recorded weekly for determination of **average daily gain (ADG)**, **average daily feed intake (ADFI)**, **gain to feed ratio (G:F)**, and **feed to gain ratio (F:G)**.

Results – w 7d postweaning

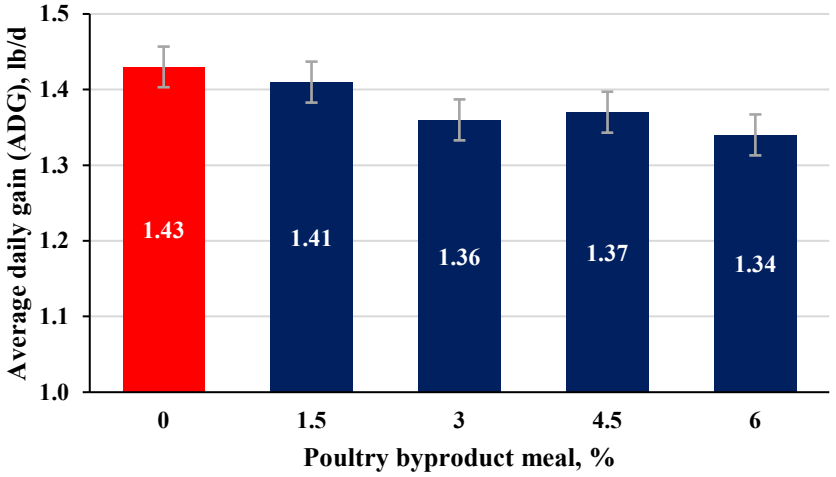
Ingredient composition of PBM diets

	Phase 1			Phase 2		
Item[1], %	0% PBM	6% PBM	3% SDPP	0% PBM	6% PBM	3% SDPP
Corn	54.42	55.07	54.78	60.65	61.36	60.95
SBM, 48%	40.00	34.00	37.00	34.10	28.10	31.10
PBM	**-**	**6.00**	**-**	**-**	**6.00**	**-**
SDPP	-	-	3.00	-	-	3.00
Others[2]	5.58	4.93	5.22	5.25	4.54	4.95
Calculated composition						
SID Lys[3]	1.351	1.350	1.356	1.231	1.238	1.235
Ca	0.806	0.807	0.803	0.709	0.705	0.703
STTD P[4]	0.405	0.407	0.403	0.334	0.330	0.335

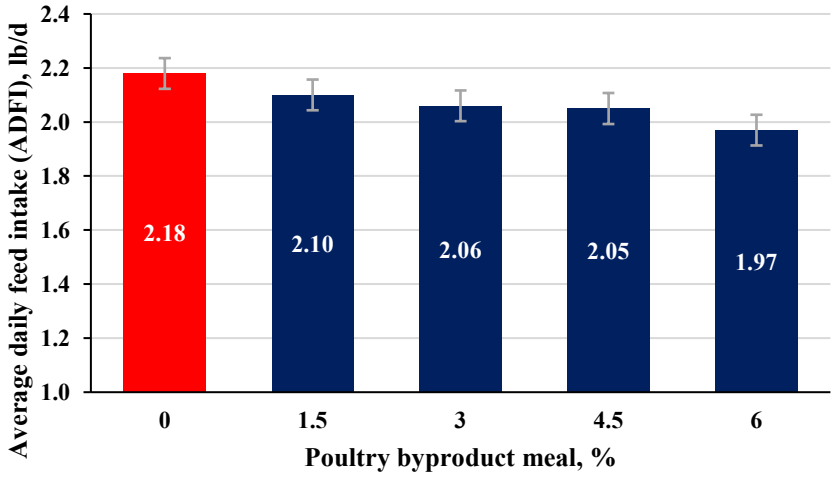
[1]SBM = soybean meal; PBM = poultry byproduct meal; SDPP = spray-dried plasma protein.
[2]Others include grease, L-Lys, DL-Met, L-Thr, dicalcium phosphate, limestone, salt, trace mineral premix, vitamin premix, and santoquin.
[3]SID = standardized ileal digestible.
[4]STTD = standardized total tract digestible.

Growth performance (overall d 0-28)

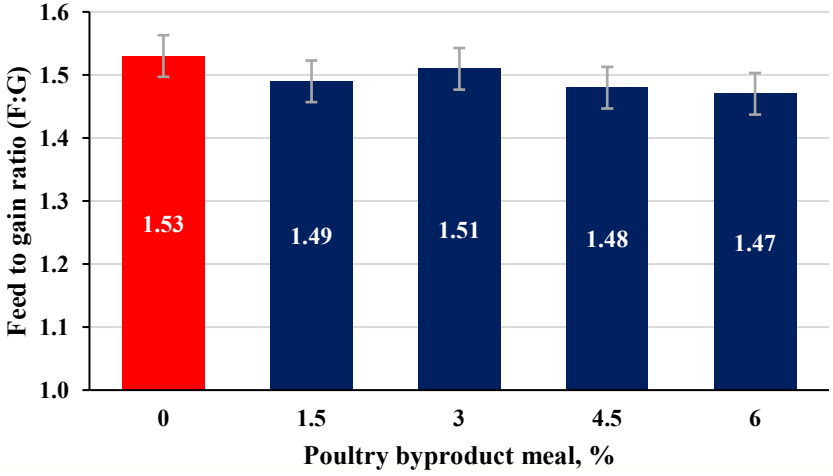
Linear: $P = 0.025$, Quadratic: $P = 0.771$



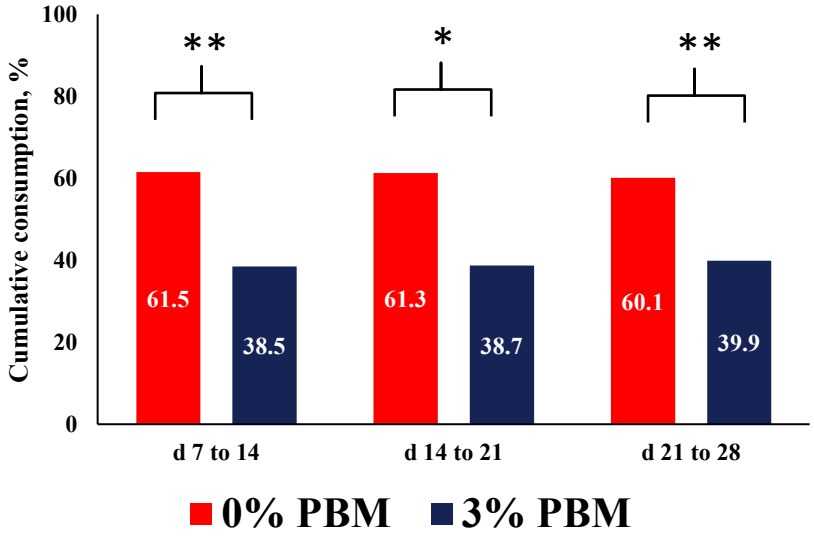
Linear: $P = 0.016$, Quadratic: $P = 0.937$

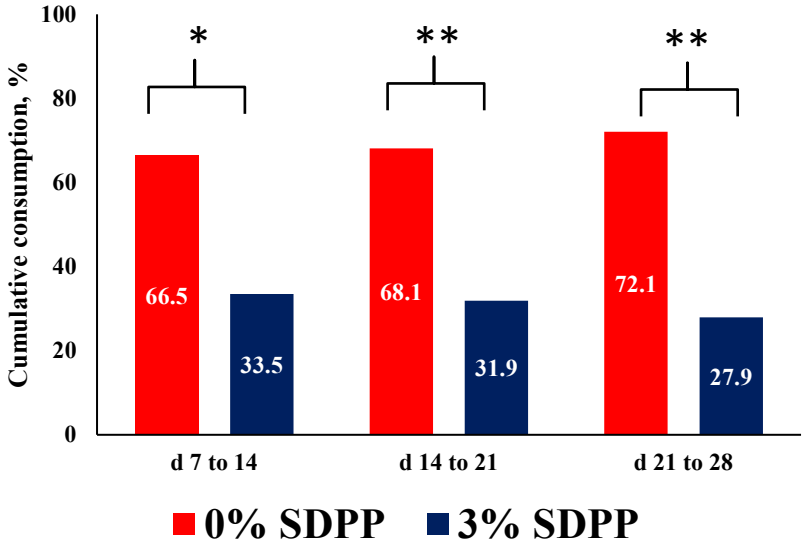


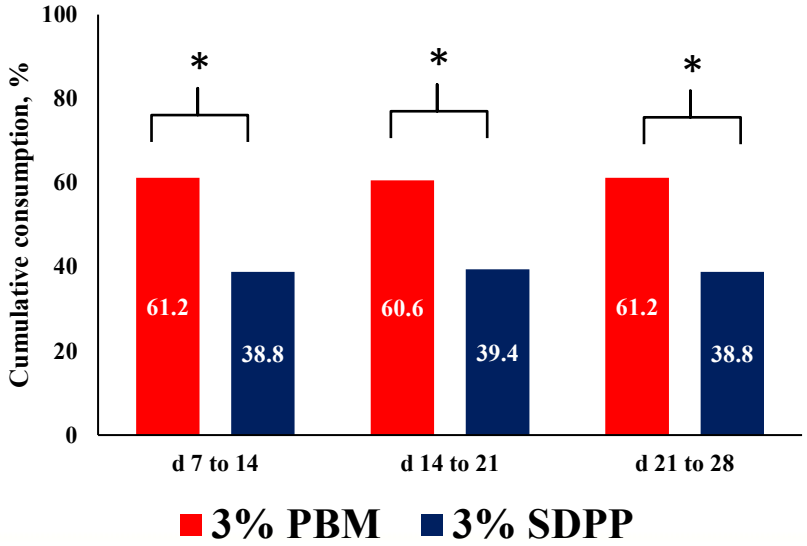
Linear: $P = 0.261$, Quadratic: $P = 0.926$



Preference (cumulative consumption)







$^{*}P < 0.05$; $^{**}P < 0.01$

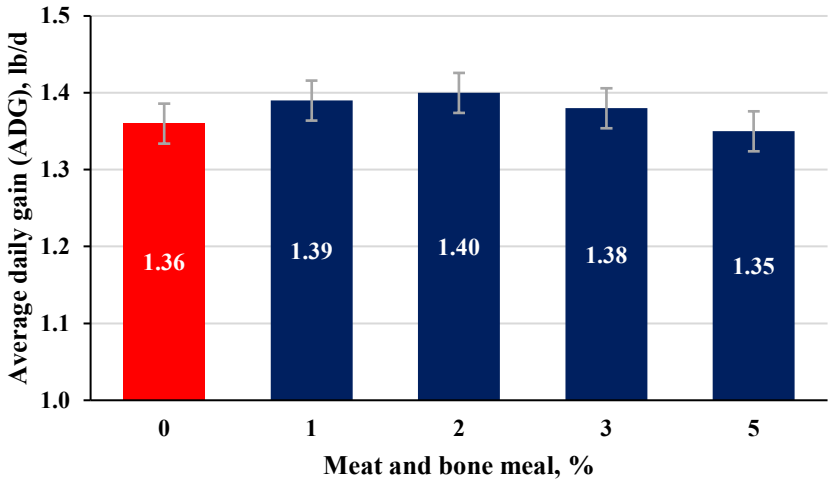
Ingredient composition of MBM diets

	Phase 1			Phase 2		
Item[1], %	0% MBM	5% MBM	2% SDPP	0% MBM	5% MBM	2% SDPP
Corn	54.49	56.31	54.74	60.83	62.64	61.06
SBM, 48%	40.00	35.00	38.00	34.00	29.00	32.00
MBM	**-**	**5.00**	**-**	**-**	**5.00**	**-**
SDPP	-	-	2.00	-	-	2.00
Others[2]	5.51	3.69	5.26	5.17	3.36	4.94
Calculated composition						
SID Lys[3]	1.357	1.358	1.352	1.235	1.235	1.238
Ca	0.806	0.802	0.801	0.704	0.701	0.704
STTD P[4]	0.404	0.403	0.404	0.333	0.338	0.336

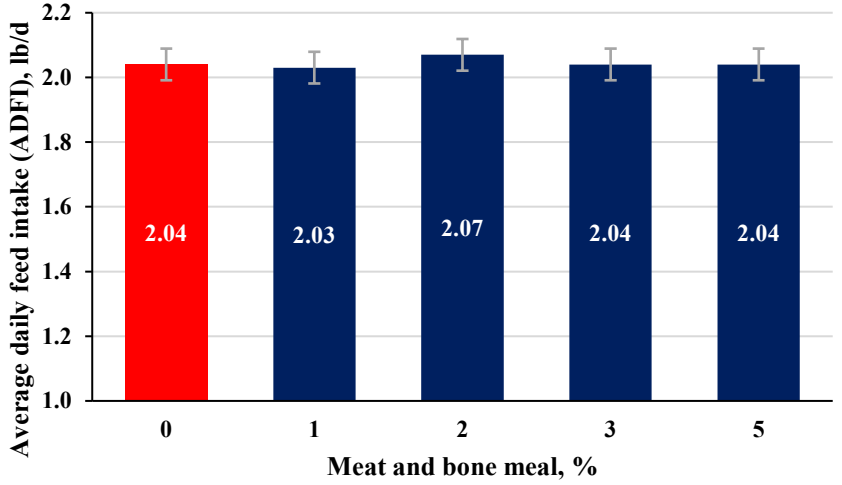
[1]SBM = soybean meal; MBM = meat and bone meal; SDPP = spray-dried plasma protein.
[2]Others include grease, L-Lys, DL-Met, L-Thr, dicalcium phosphate, limestone, salt, trace mineral premix, vitamin premix, and santoquin.
[3]SID = standardized ileal digestible.
[4]STTD = standardized total tract digestible.

Growth performance (overall d 0-29)

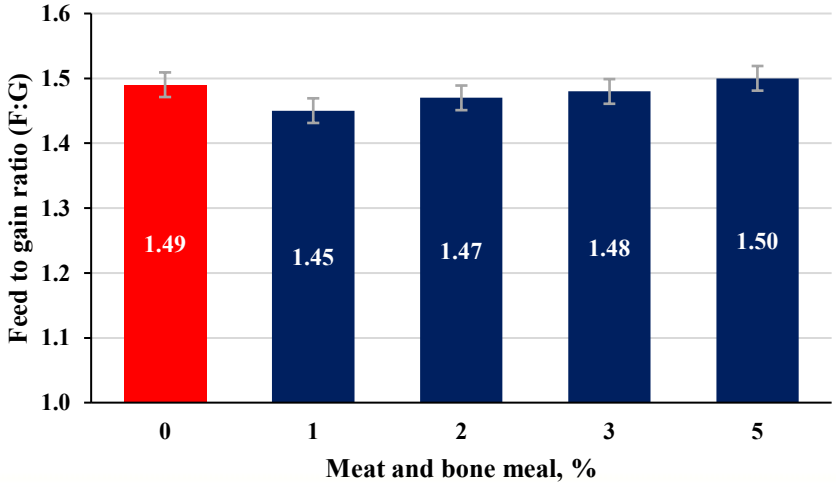
Linear: $P = 0.641$, Quadratic: $P = 0.191$



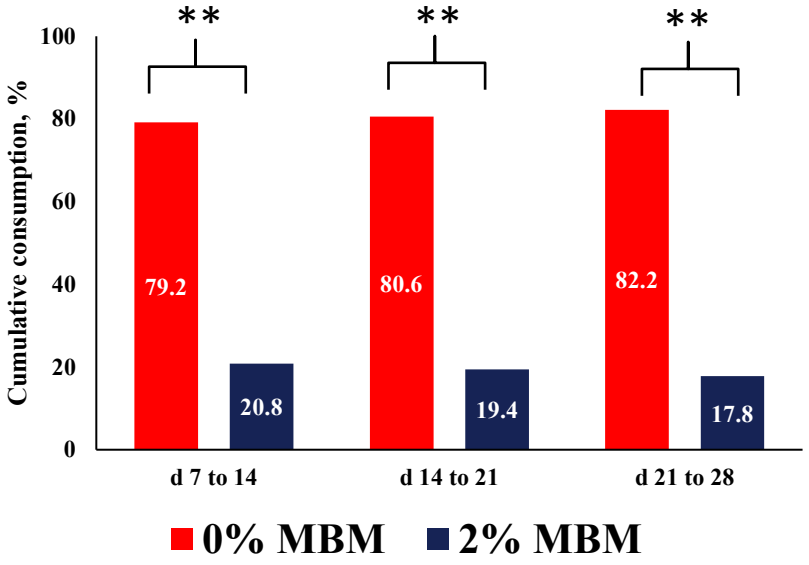
Linear: $P = 0.955$, Quadratic: $P = 0.771$

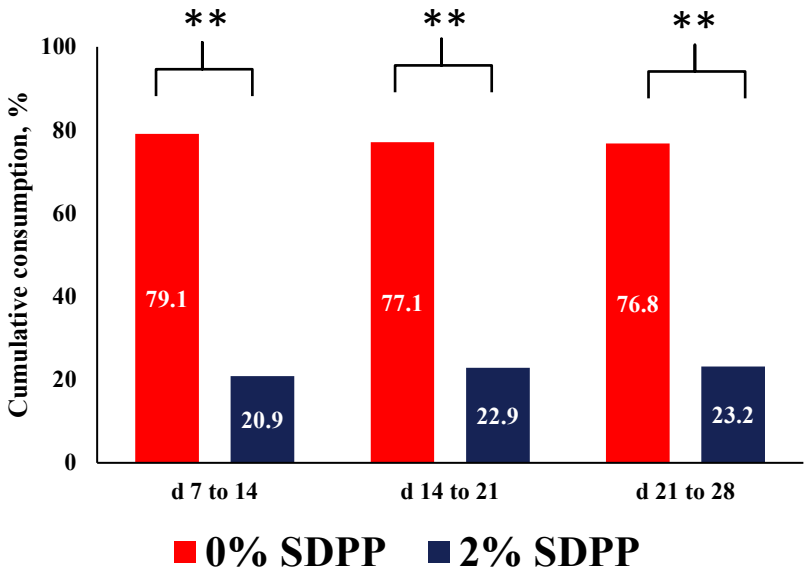


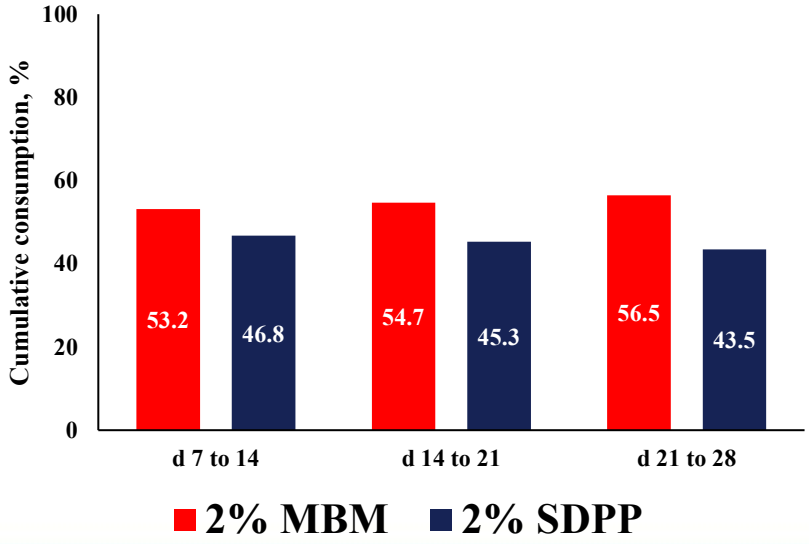
Linear: $P = 0.360$, Quadratic: $P = 0.142$



Preference (cumulative consumption)



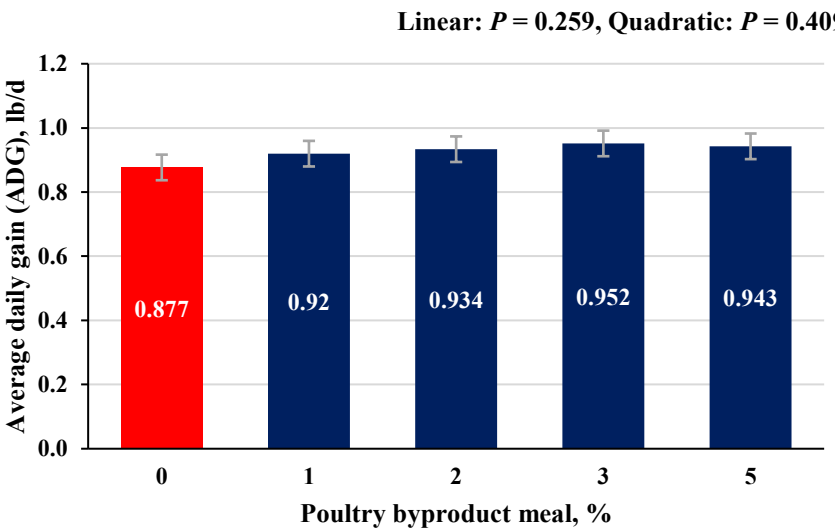


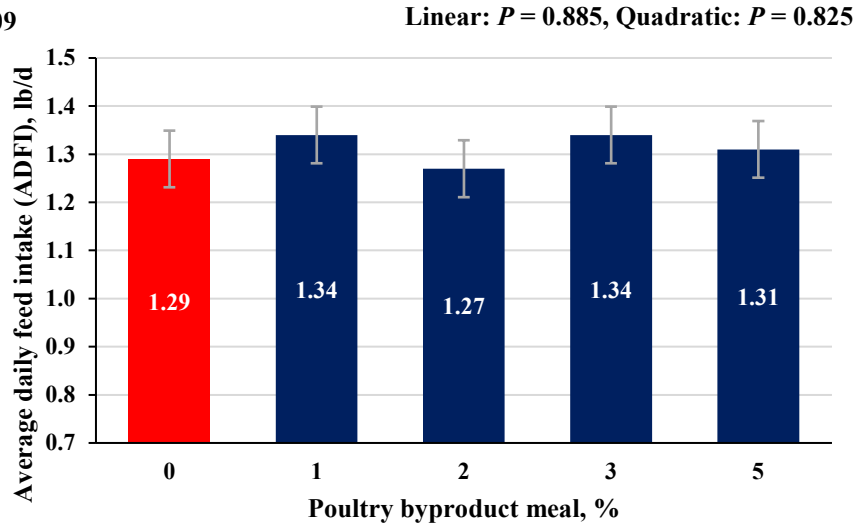


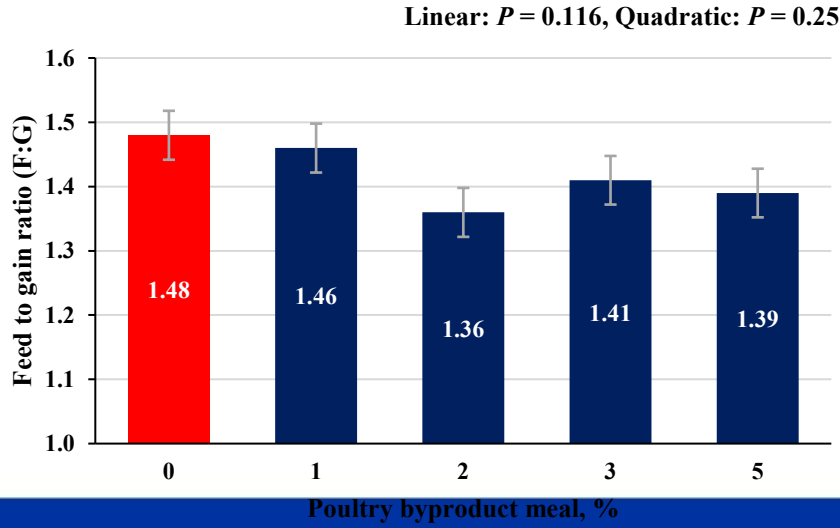
$^{*}P < 0.05$; $^{**}P < 0.01$

Results – w 0d postweaning

Growth performance (overall d 0-28)







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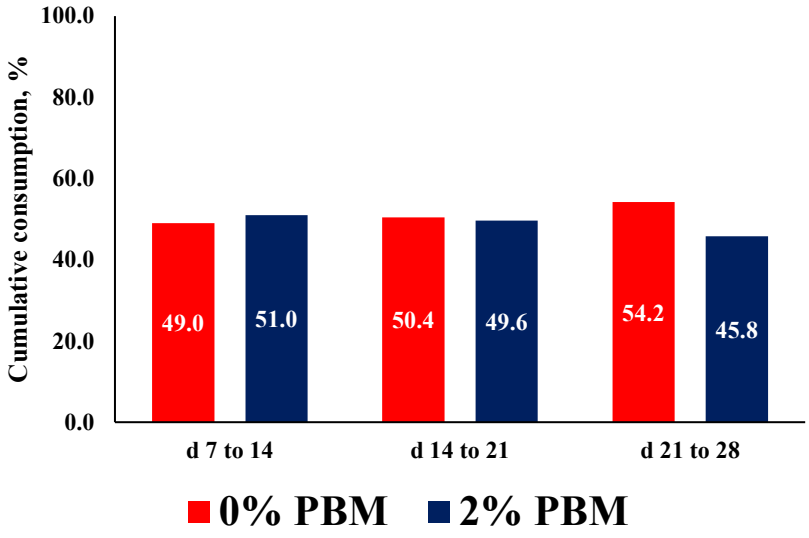
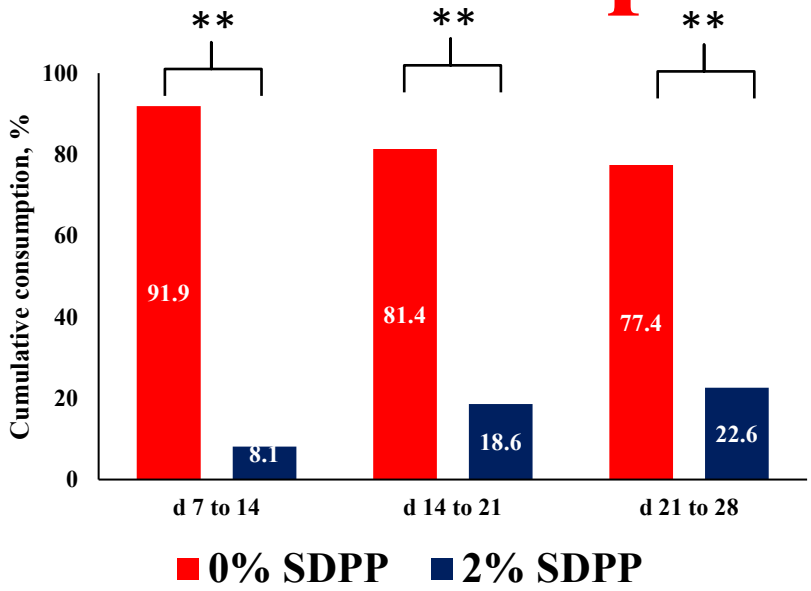
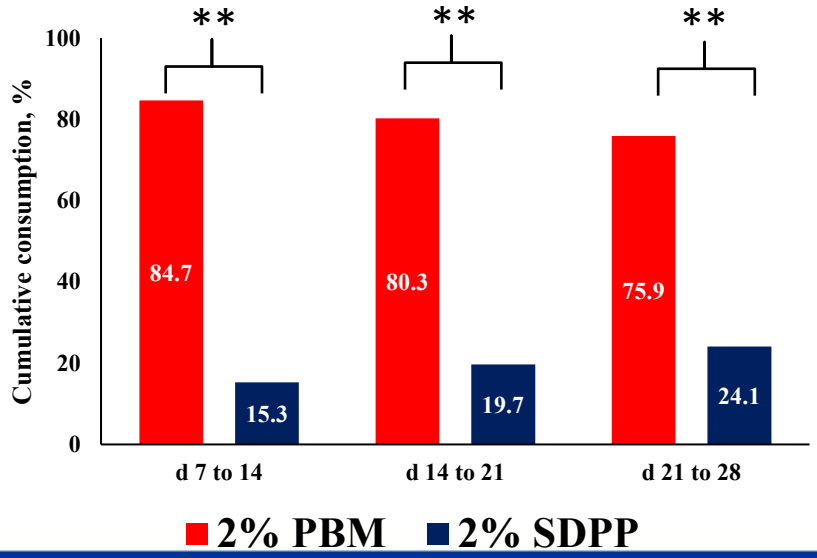


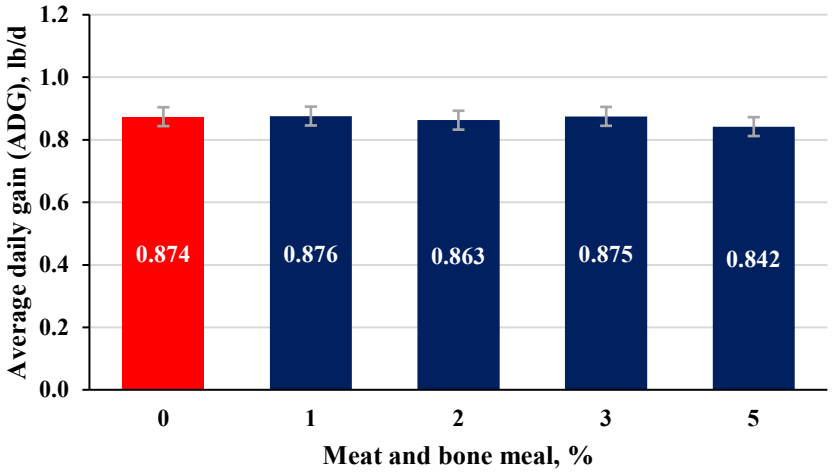




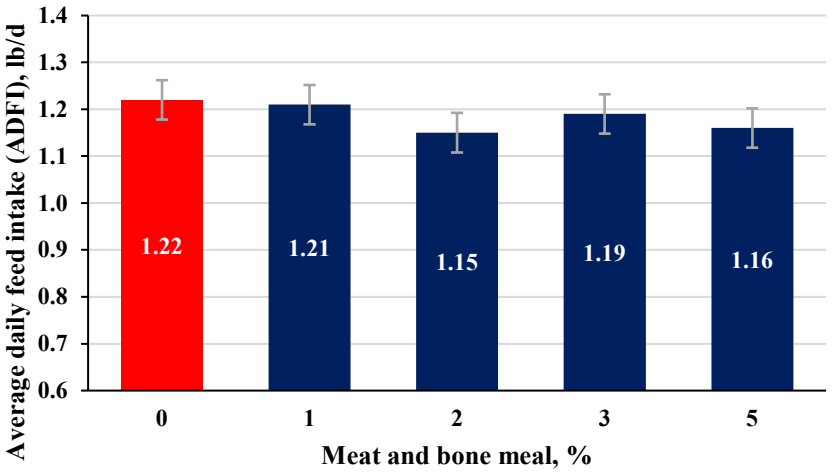
$^{*}P < 0.05$; $^{**}P < 0.01$

Growth performance (overall d 0-28)

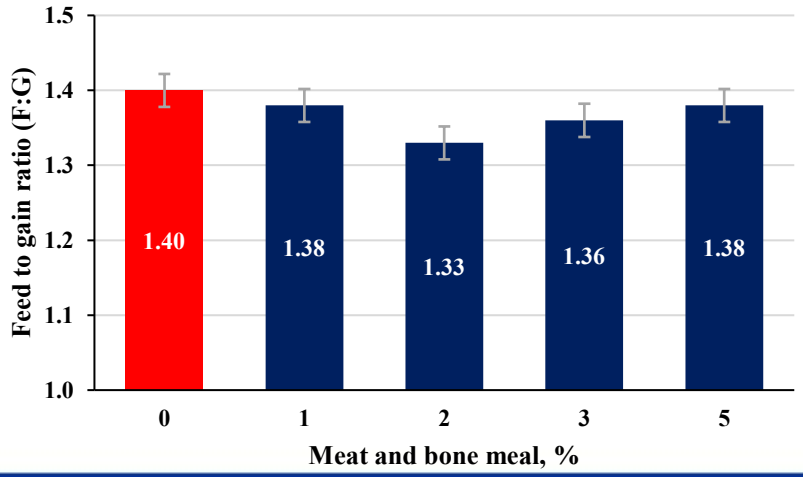
Linear: $P = 0.457$, Quadratic: $P = 0.709$



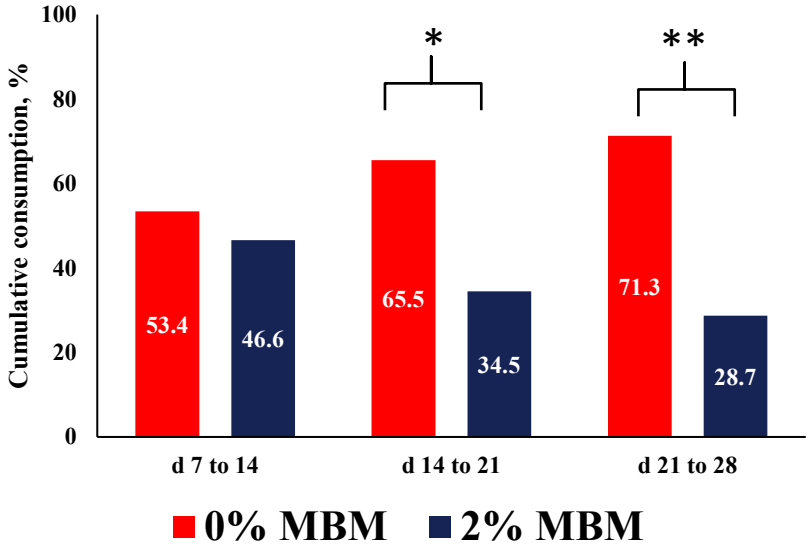
Linear: $P = 0.350$, Quadratic: $P = 0.577$

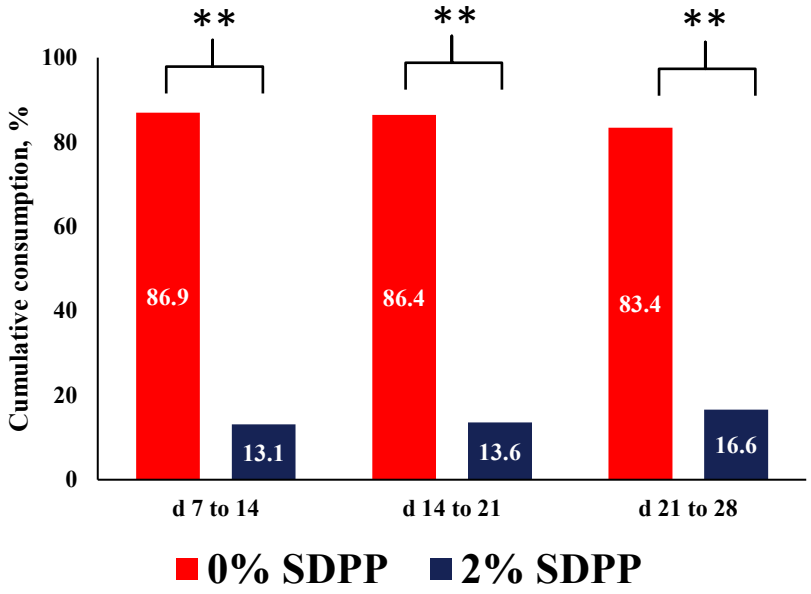


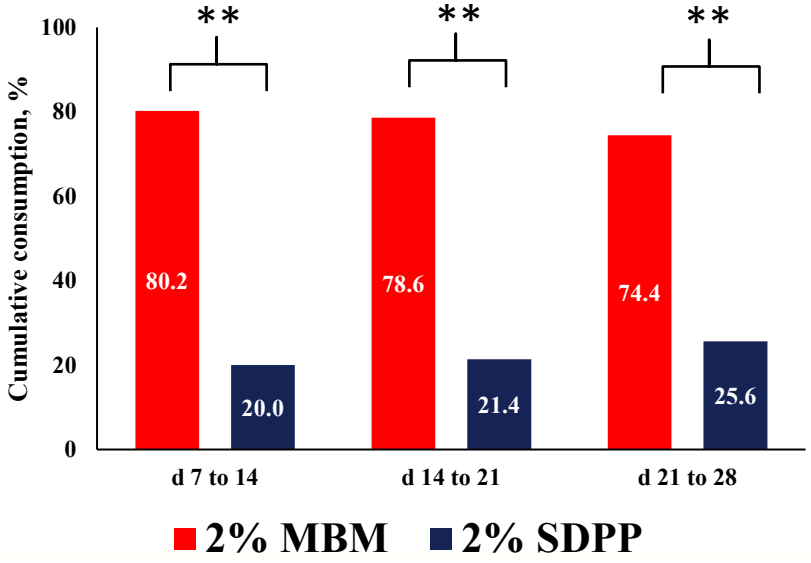
Linear: $P = 0.566$, Quadratic: $P = 0.054$



Preference (cumulative consumption)



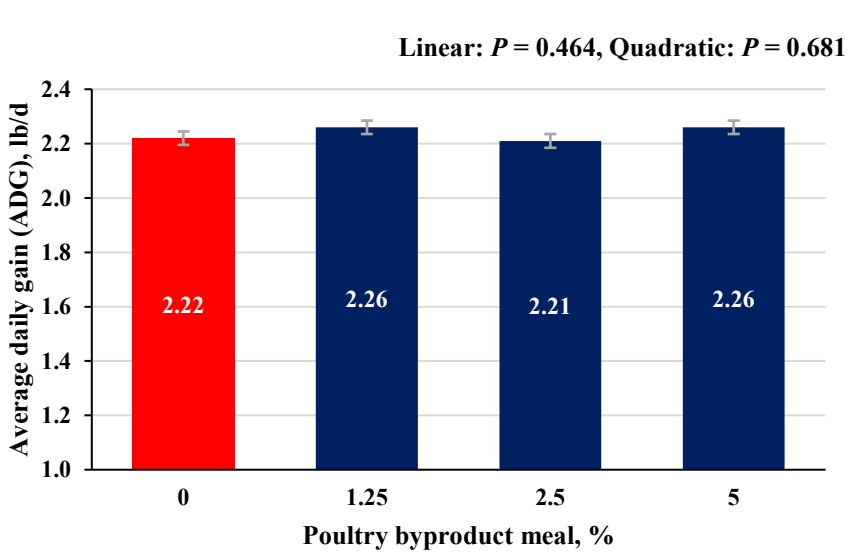


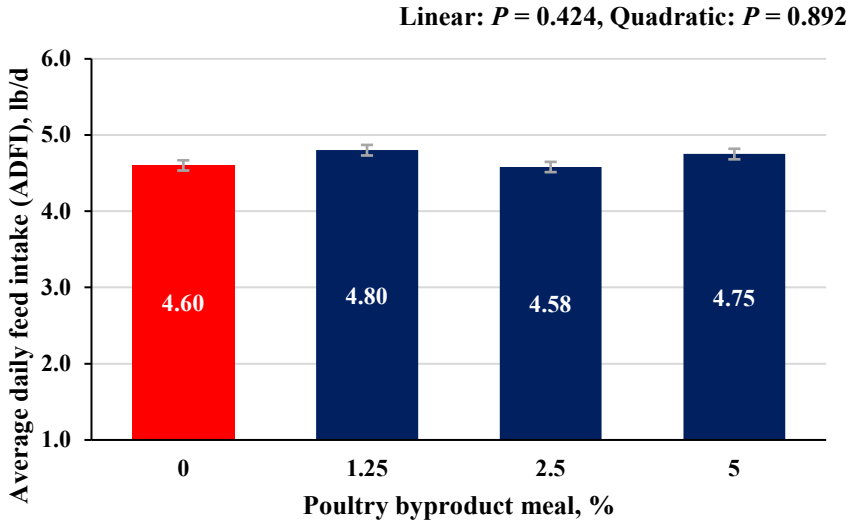


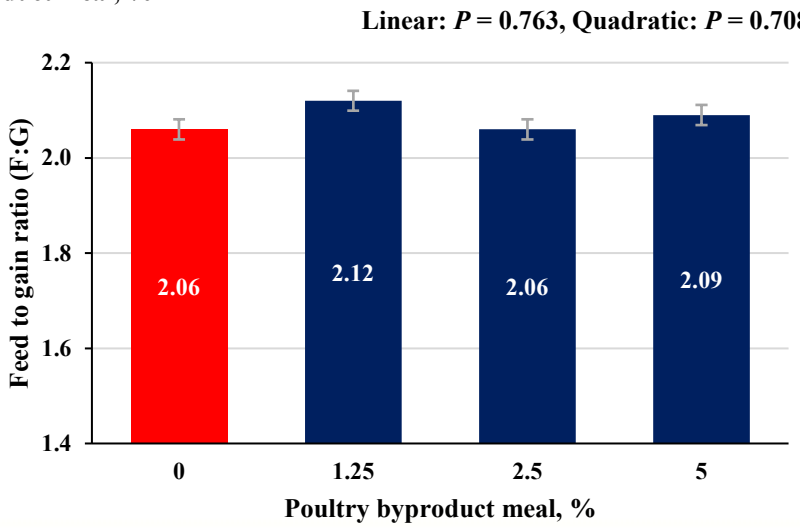
$^{*}P < 0.05$; $^{**}P < 0.01$

Results – grower period

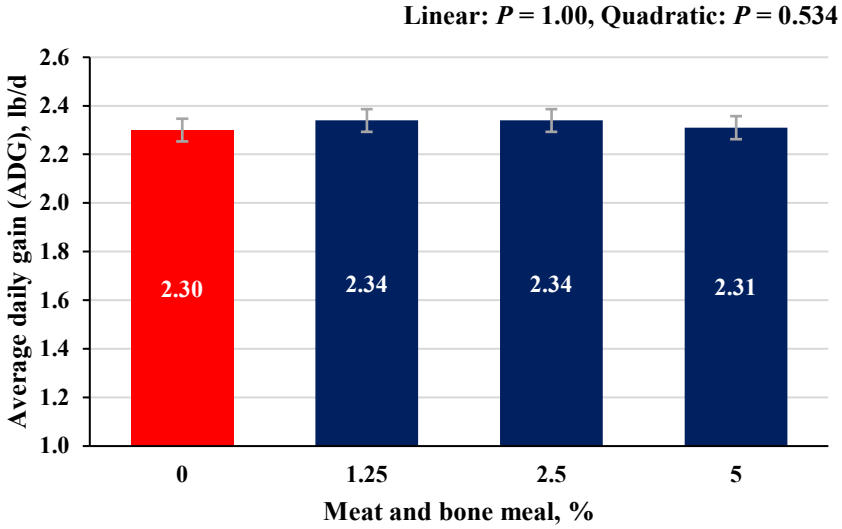
Growth performance (overall d 0-41)

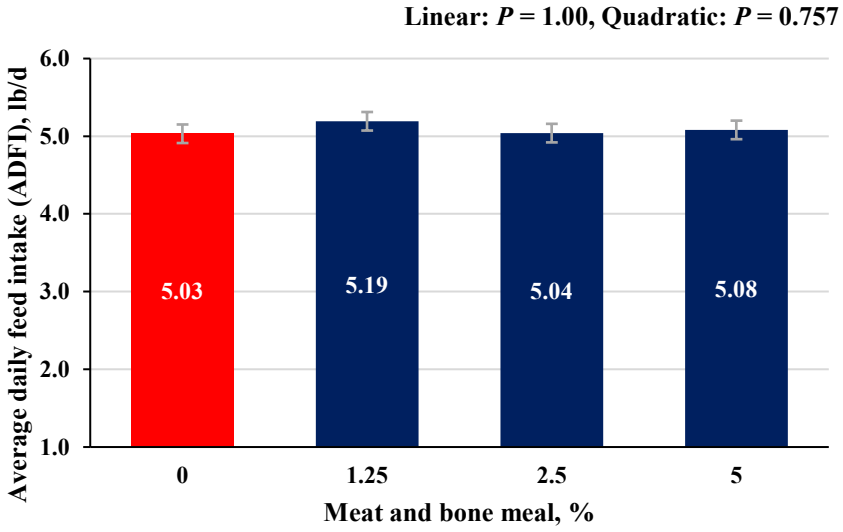


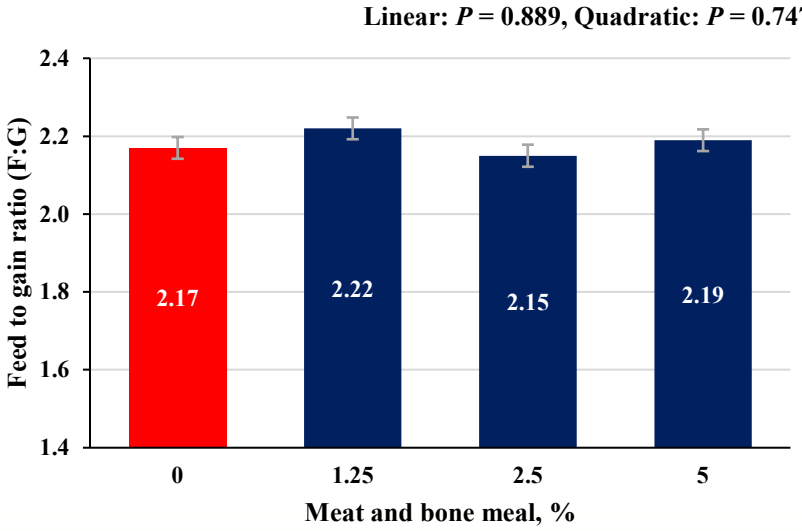




Growth performance (overall d 0-42)







Conclusions

- An increase in the level of PBM or MBM in the first nursery diets (**immediately at weaning**) from 0 to 5% did not affect **overall growth performance** or **feed efficiency of pigs** during the 28-d period demonstrating they are **excellent nursery feed ingredients**.

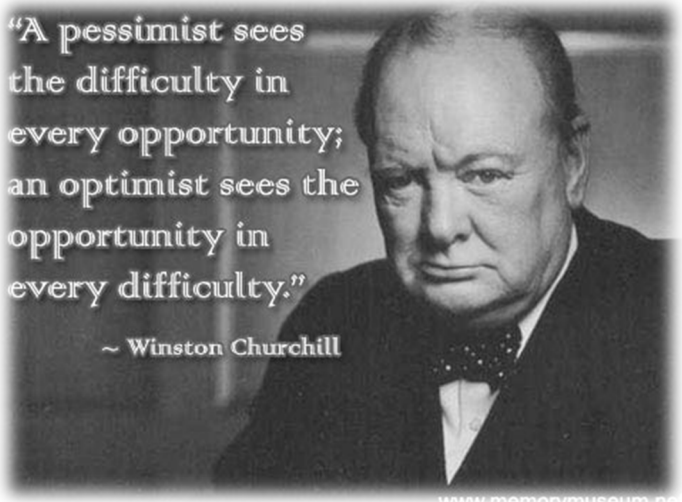
- Pigs preferred the **control diet without an animal product** (PBM, MBM, or SDPP) over the animal product-based diets.

- When comparing the two animal products (2% PBM or 2% MBM vs. 2% SDPP), pigs exhibited a clear preference **for 2% PBM or 2% MBM** over 2% SDPP under the conditions used in this study.

- Increasing the level of PBM or MBM in the **grower diets** from 0 to 5% resulted in no differences in **overall growth performance** or **feed efficiency of pigs** during the 41 to 42-d feeding period, again demonstrating they are **excellent grower feed ingredients**.

- "**A pessimist sees the difficulty** in every opportunity. ***An optimist sees the opportunity*** in every difficulty."

-Winston Churchill-



Questions/Opportunities

- Would a blend of SDPP and either PBM or MBM yield a different response?

- Additional research into the ileal digestibility of amino acids of differently sourced PBM.

- Grower pig performance was excellent. Nursery pig performance suggested improved digestibility with both products. Compare products to SBM in a grower or finisher study designed to evaluate the relative bioavailability of amino acids.

Acknowledgments

- **Fats and Proteins Research Foundation**
- **Darling Ingredients Inc.**

Thank you for your attention!!!

*** No graduate students were harmed in the conduct of these experiments.**