Practical Options for PEDv Mitigation During Feed Manufacturing

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November 19th, 2015
K-State Swine Day

Prevention of Biological Hazards in Feed

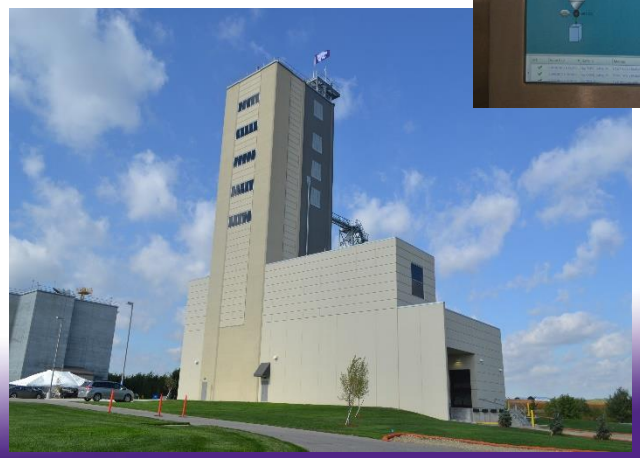
- Why is PEDv mitigation important?
  - Control animal food safety hazards to fulfill our role in preserving farm-to-fork food safety.

K-State Study 1: PEDv is highly infectious!

- **With PEDv, a dose as low as 200 infectious particles** in feed has been demonstrated to result in pig infection.
- An acutely infected piglet can produce 100,000,000 infectious particles per gram of feces
- Thus, 1 gram of feces from an acutely infected pig could contaminate up to 500 tons of feed with each gram of feed being infectious

Cargill Feed Safety Research Center

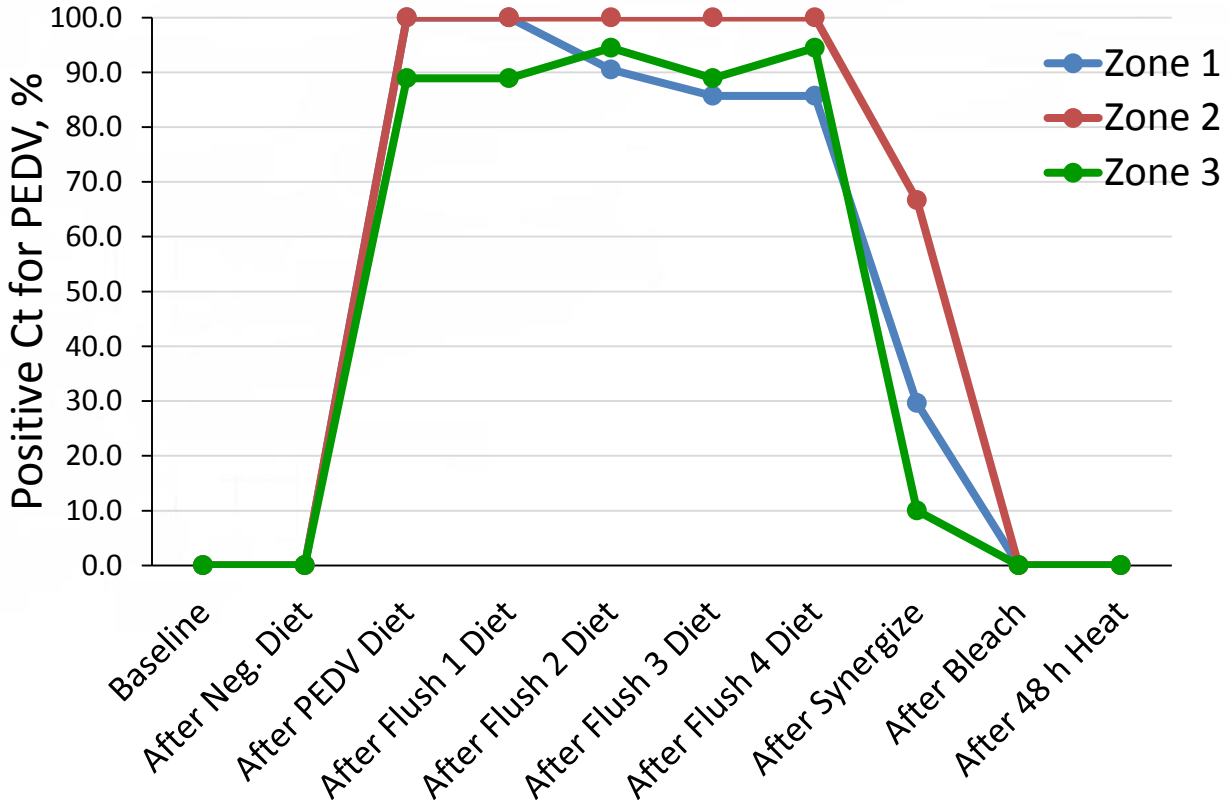
- 3 story BSL-2 Lab
  - *Salmonella*, E. Faecium, PEDV
  - Pellet mills, coolers, and bagging capacities
  - Containment mode
    - Equipped with sanitation features
    - Air flow alarms
    - HEPA filters
    - Decontamination



KSU Study 2: What happens when PEDv contaminated feed is produced?

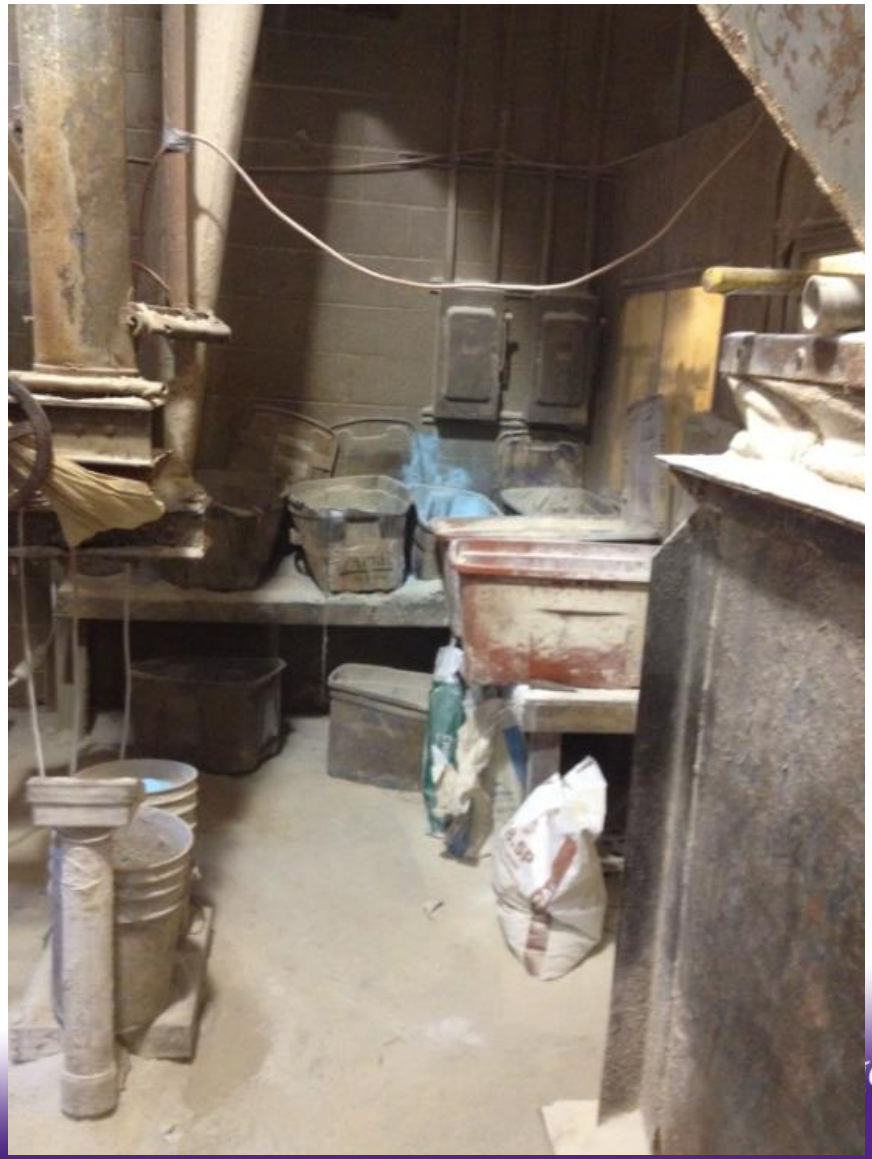
- 3 replications (days) of PEDv-inoculated feed mixed, discharged through a bucket elevator in the FSRC.
- Environmental swabs collected of equipment and facility surfaces after each batch and analyzed via PCR for detection of PEDv.

Environmental contamination after processing PEDv-inoculated feed



Zone 1 = direct feed contact surfaces- equipment interiors
Zone 2 = surfaces directly adjacent to zone 1
Zone 3 = structural surfaces- floors, walls

Preventing cross contamination during production: Housekeeping



Mitigation of Hazards

- Dust Collection

DO NOT add back to the feed!

KSU Study 3: Can PEDv Infectivity Be Reduced by Flushing or Sequencing Diets?

- Sequencing or flushing are recognized cleanout procedures for CGMPs of medicated feed
- One batch of PEDv-negative feed mixed, conveyed through bucket elevator, discharged
- One batch of PEDv-positive feed followed
- Four subsequent sequences of PEDv-negative feed followed
  - Feed and environmental samples at multiple locations collected after each batch

KSU Study 3: Can PEDv Infectivity Be Reduced by Flushing or Sequencing Diets?

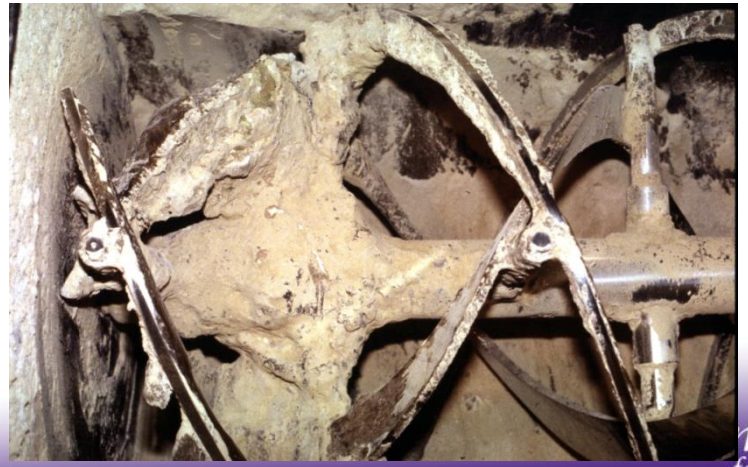
Number of Feed Samples When PEDv was Detected by PCR

	Time Point				
Location	After PEDV Diet	After Sequence 1	After Sequence 2	After Sequence 3	After Sequence 4
Mixer	9/9	7/9	**0**	0	0
Bucket Elevator	9/9	7/9	2/9	0	0

Number of Pigs Infected with PEDv by Bioassay

	Time Point				
Location	After PEDV Diet	After Sequence 1	After Sequence 2	After Sequence 3	After Sequence 4
2 dpi (fecal)	9/9	1/9	**1/9**	?	?
7 dpi (cecum)	9/9	3/9	3/9	?	?

Feed mills decontamination can be a challenge



KSU Study 4: Can Pelleting Reduce the Infectivity of PEDv?

- Low dose and high dose (20 and 13 Ct)
- 3 pellet mill conditioner retention times (45, 90, 180 s)
- 3 conditioning temperatures (155, 175, 195°F)

Low Dose PCR Ct Values (20 Ct)

	Time, sec		
Temp, °F	**45**	**90**	**180**
155	43	40	45
175	37	40	42
195	40	37	36

High Dose PCR Ct Values (13 Ct)

	Time, sec		
Temp, °F	**45**	**90**	**180**
155	30	30	30
175	30	30	30
195	30	31	30

Low Dose Feed No processing = 31

High Dose Feed No processing = 24

No infectivity developed from any of the pelleted diets

KSU Study 5: Is There Risk for PEDv Infectivity at Lower Conditioning Temperatures?

- Single dose (11 Ct)
- Single conditioner retention time (30 s)
- 5 conditioning temperatures (100, 115, 130, 145, and 160°F)
- Replicated manufacturing conditions
  - 3 pigs/room – one from each manufacturing rep

PCR Ct Values

	Time, sec
Temp, °F	**30**
100	32.5
115	34.7
130	37.0
145	36.5
160	36.7

KSU Study 5: Is There Risk for PEDv Infectivity at Lower Conditioning Temperatures?

Number of Pigs Infected with PEDv by Bioassay

	Feed	0 dpi	2 dpi	4 dpi	6 dpi	7 dpi	7 dpi Cecum
No PEDV	0	0	0	0	0	0	0
100°F	9/9	0	1/9	3/9	3/9	3/9	3/9
115°F	9/9	0	3/9	3/9	3/9	3/9	3/9
130°F	9/9	0	0	0	0	0	0
145°F	8/9	0	0	0	0	0	0
160°F	8/9	0	0	0	0	0	0

Infectivity developed in diets pelleted below 130°F

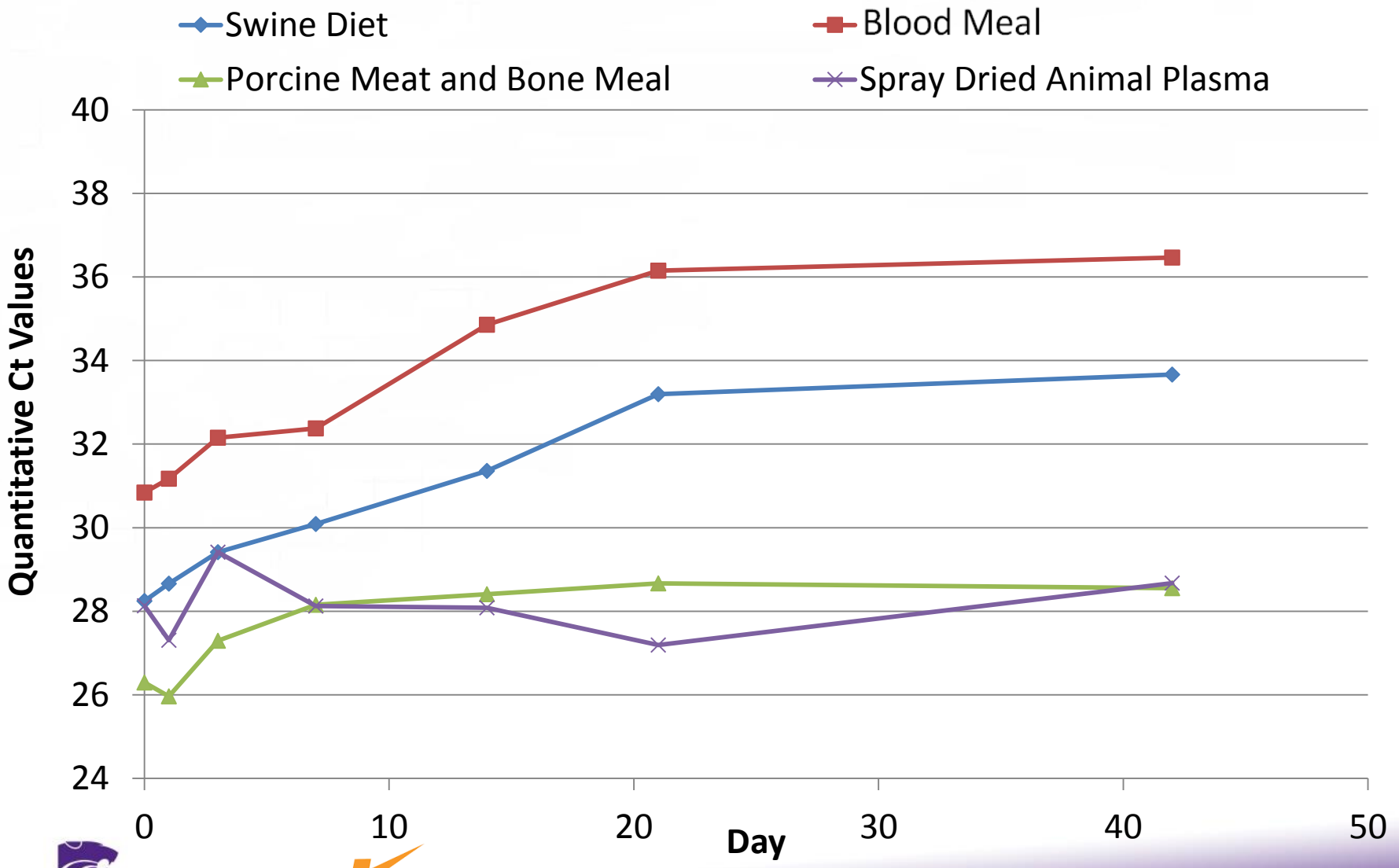
KSU Study 5: Is There Risk for PEDv Infectivity at Lower Conditioning Temperatures?

- Thermal mitigation of PEDv by pelleting
  - When is feed NOT conditioned to at least 130°F?
    - Intentional extremely low conditioning temperatures (rare)
    - Start-up
    - Plugged dies
  - Other potential mitigation strategies may be necessary to consider IN ADDITION to pelleting

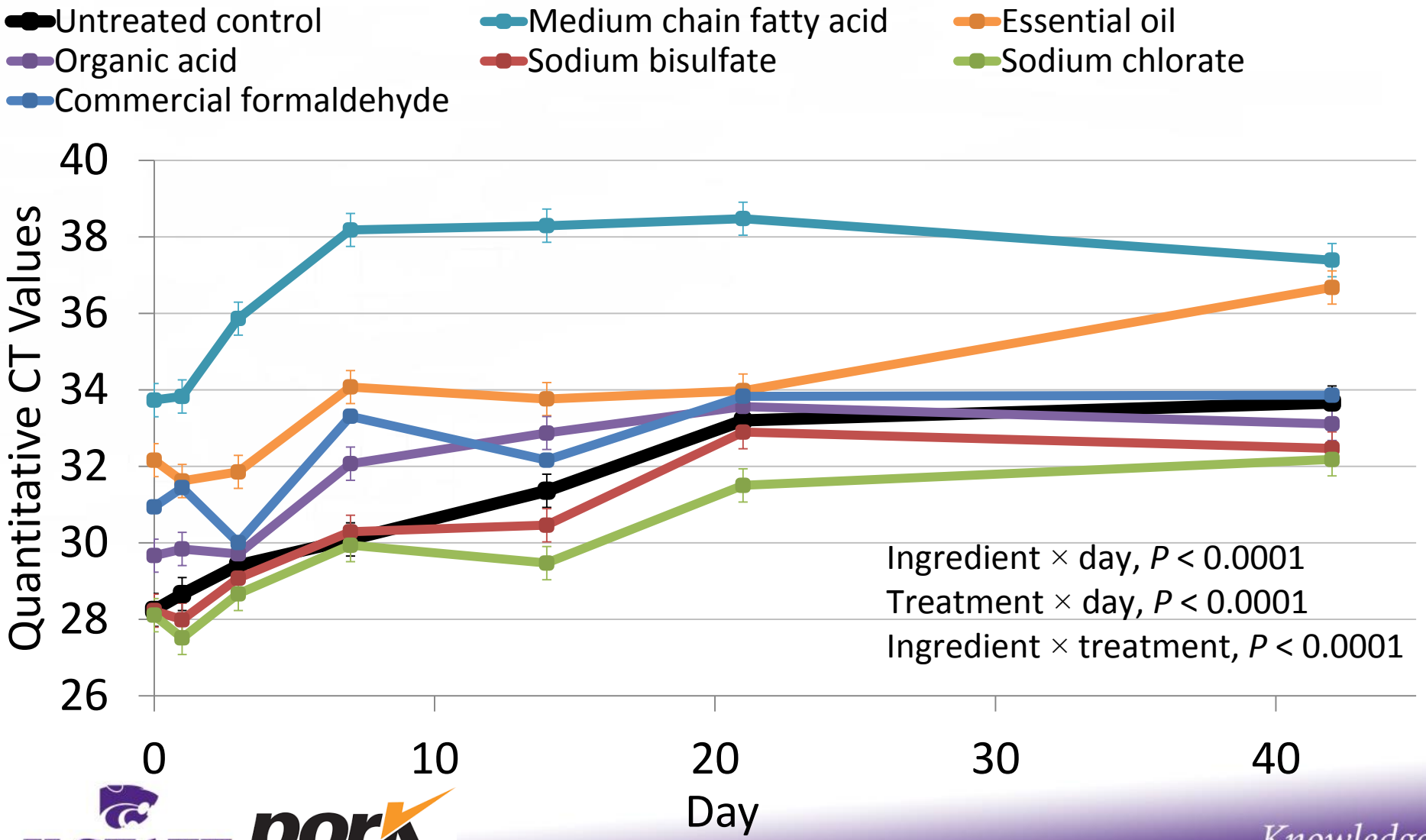
KSU Study 6: Can Chemicals be Added to Feed or Ingredients to Reduce the Risk of PEDv Cross-Contamination?

- 4 different feed or ingredients to be treated:
  - Complete nursery feed, porcine MBM, blood meal, SDAP
- 5 chemical treatments:
  - Organic acids, essential oils, sodium bisulfate, Termin-8, and sodium chlorate
- After the feed or ingredients were treated they were inoculated with PEDv (5.6 x 10^4 TCID 50/g)
- Samples evaluated on days 0, 1, 3, 7, 14, 21, and 42 after inoculation for determination of PEDv RNA via RT-qPCR

Untreated Controls stored at Room Temperature



PEDv contamination post-treatment in **swine diets** stored at room temperature



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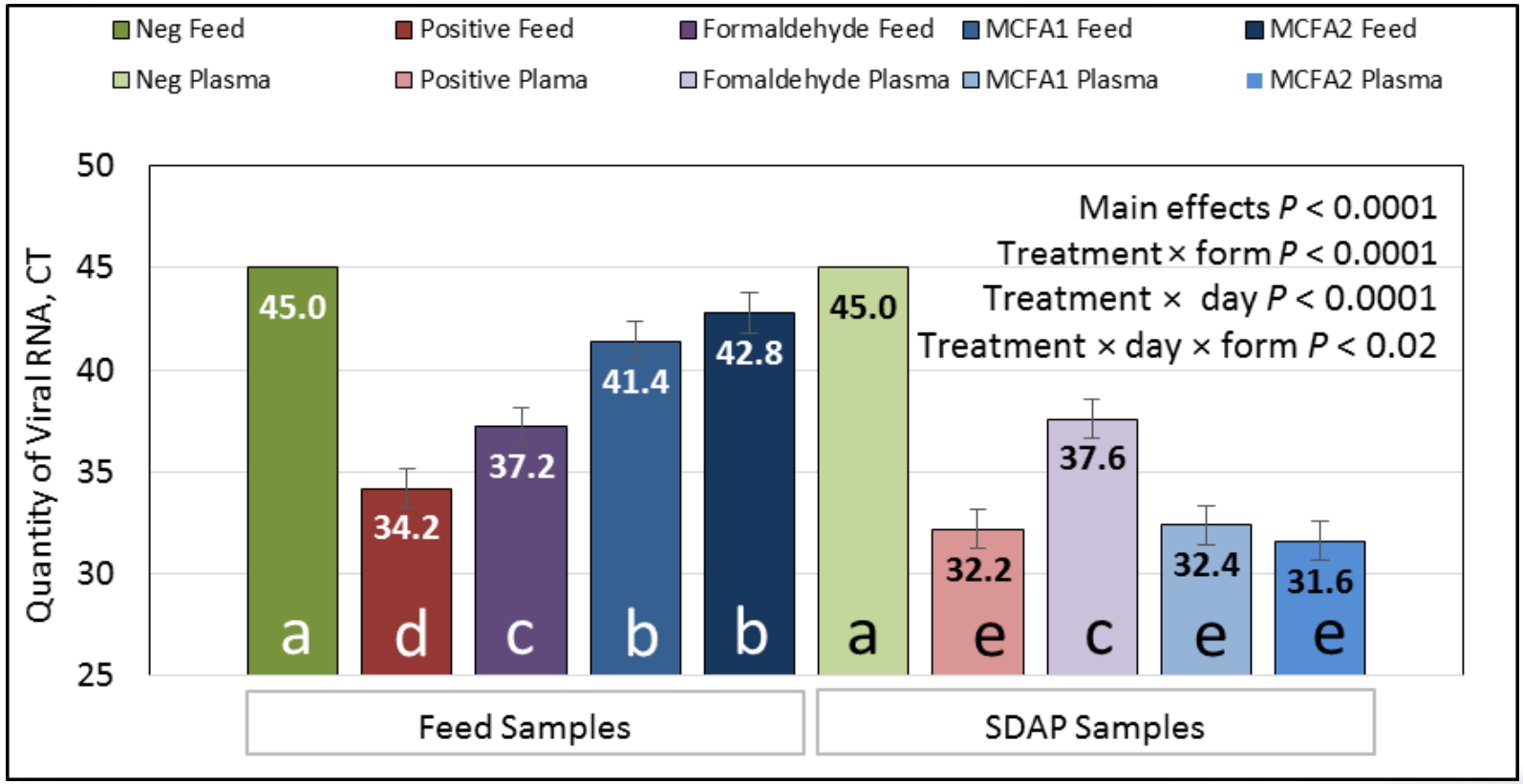
KSU Study 7: What is the Role of MCFA on Preventing PEDv Infectivity in Various Ingredients

- 15 different ingredients or feed treated:
- 3 chemical treatments:
  - Control, SalCURB, 2% MCFA blend
- Samples evaluated on days 1, 8, 27, and 37
- All samples treated with MCFA and SalCURB were non-infectious.

KSU Study 8: What Quantity of MCFA is Needed to Prevent Infectivity of PEDv?

- Bioassay scheduled in December



Summary of PEDV Findings

- Feed mill biosecurity is important to prevent cross-contamination of PEDv.
- Sequencing diets dilutes PEDv, but infectivity remains.
  - Particularly on equipment surfaces
- Diets pelleted with a 30 s conditioning time above 130°F were non-infectious.
  - Considerations required for plugs, start-up of pellet mills.
- Formaldehyde and MCFA demonstrate some ability to reduce PEDv RNA, but is ingredient dependent.
  - Effectiveness against infectivity and feasible concentrations in process of being determined.
- Multiple preventive and proactive strategies may need to be employed to maximize PEDv control.

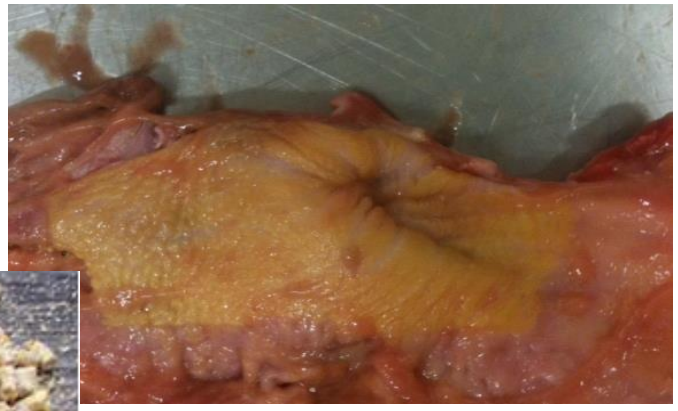
Partners for our PEDv Research

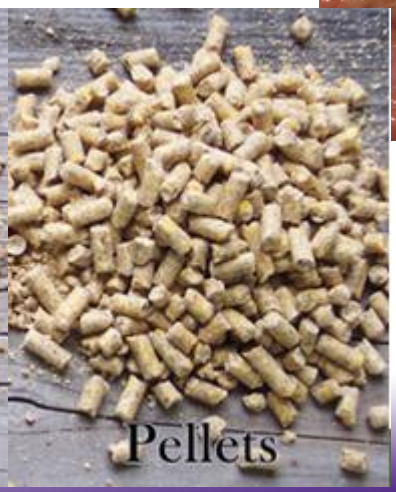
- KSU Applied Swine Nutrition Team
  - Drs. Nitikanchana, Dritz, Woodworth, Tokach, DeRouchey, Goodband, Schumacher, Jordan Gebhardt
- KSU Grain Science
  - Drs. Jones, Huss, and Stark; Roger Cochrane
- KSU VDL
  - Drs. Hesse, Bai, Haus, Anderson, and their team
- ISU VDL
  - Drs. Main, Zhang, Gauger, and their team
- National Pork Board and USDA

Impact of Feed Processing on Pig Performance

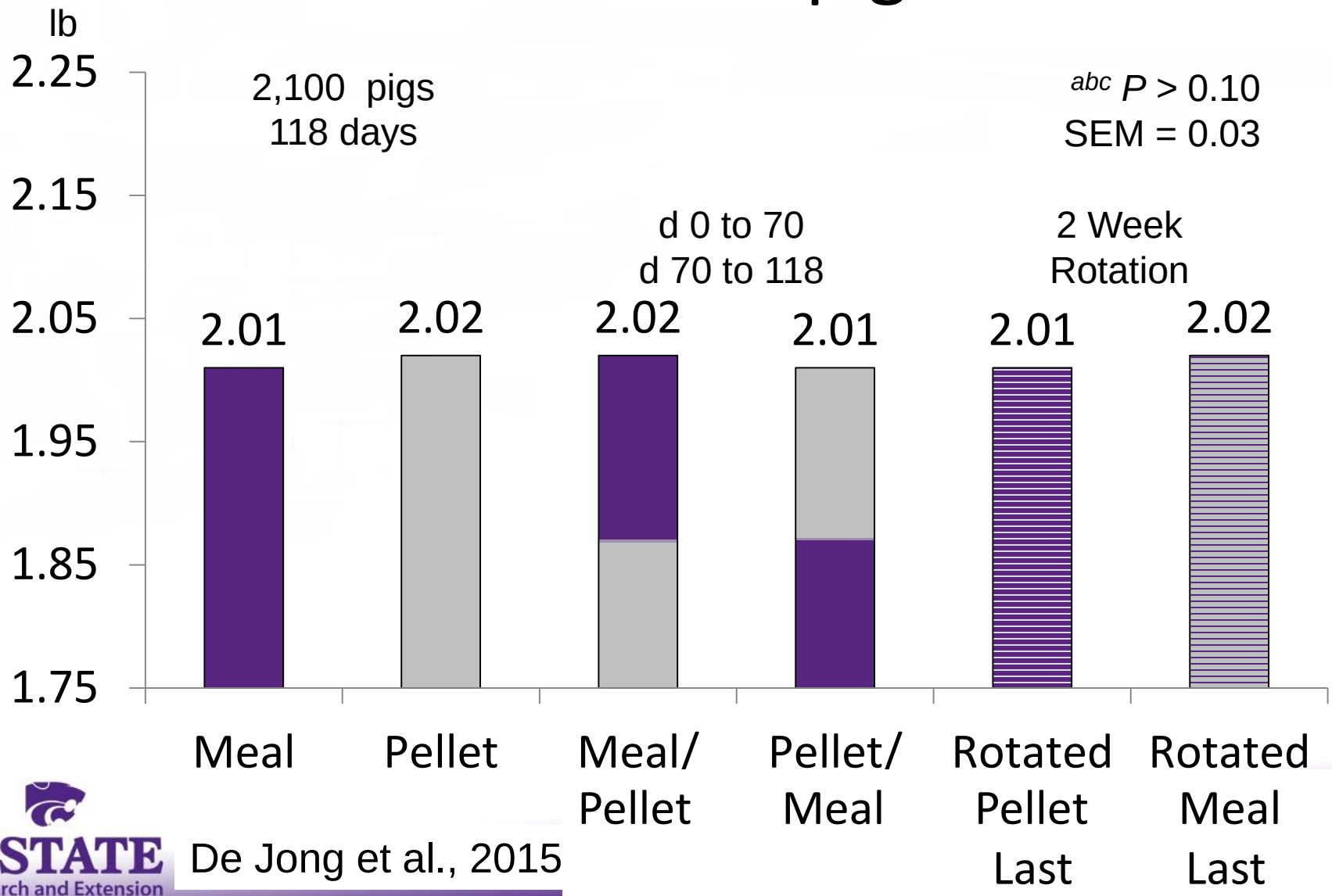
Kansas State University
Applied Swine Nutrition Team
&
Grain Science and Industry

Evaluating pellet and meal feeding regimens on finishing pig growth performance and stomach morphology





Effects of pelleting regimen on ADG of 70 to 300 lb pigs



De Jong et al., 2015

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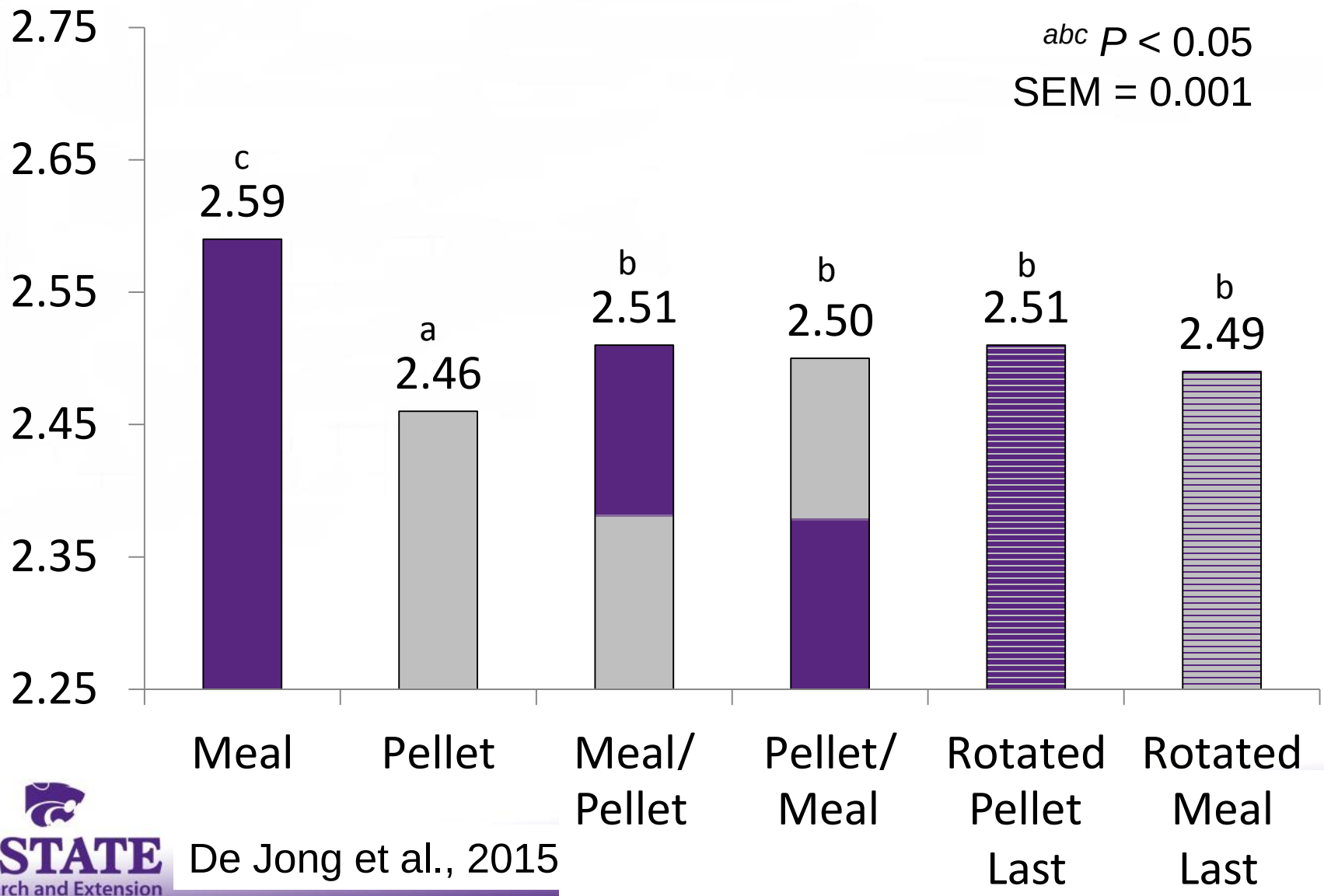
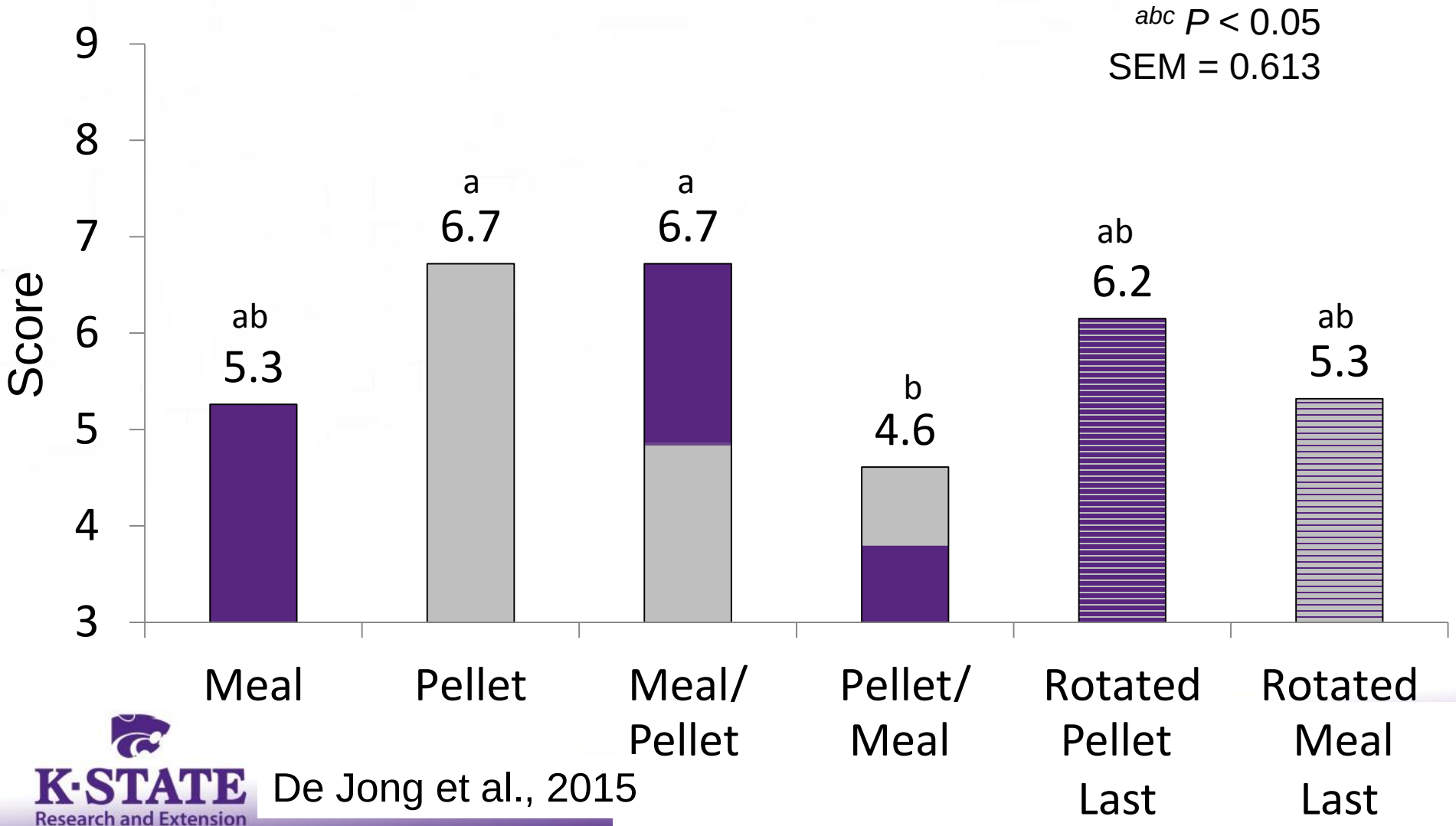
Effects of pelleting regimen on F/G



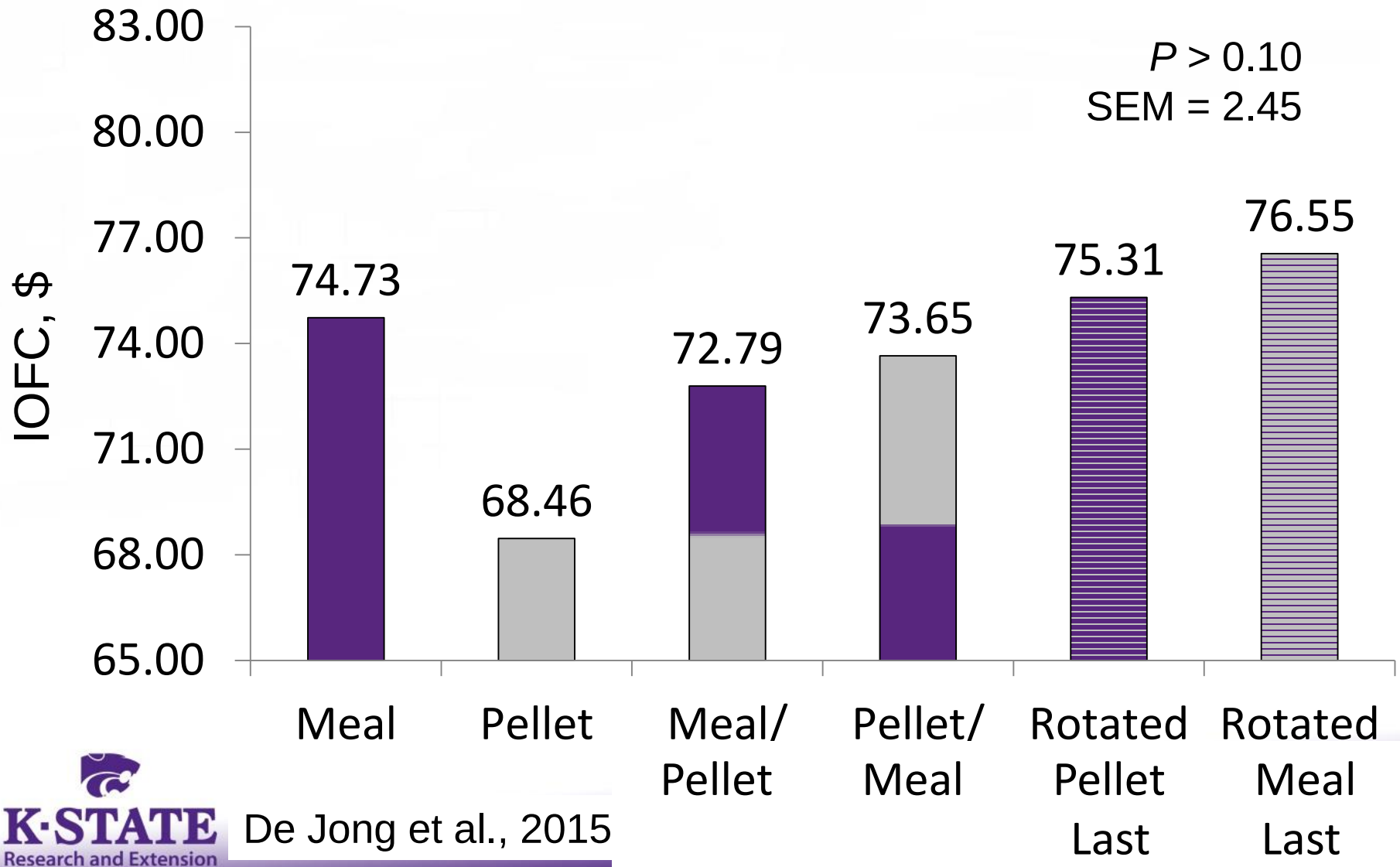
De Jong et al., 2015

Effects of pelleting regimen on stomach morphology (combined ulceration & keratinization)



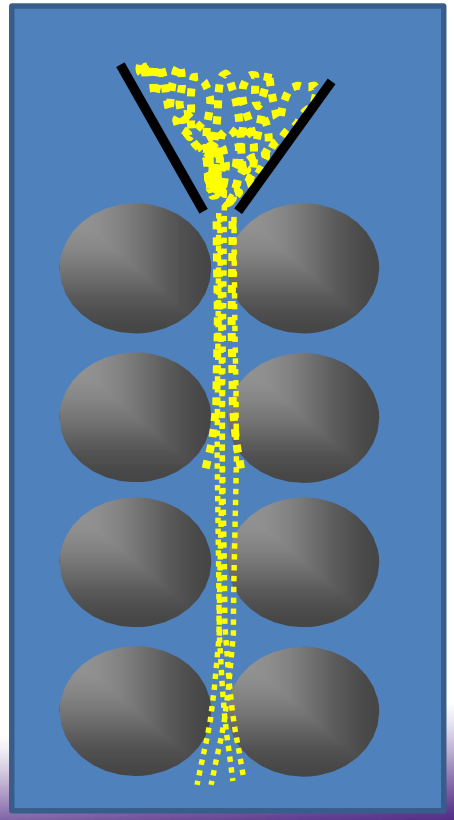
De Jong et al., 2015

Effects of pelleting regimen on IOFC

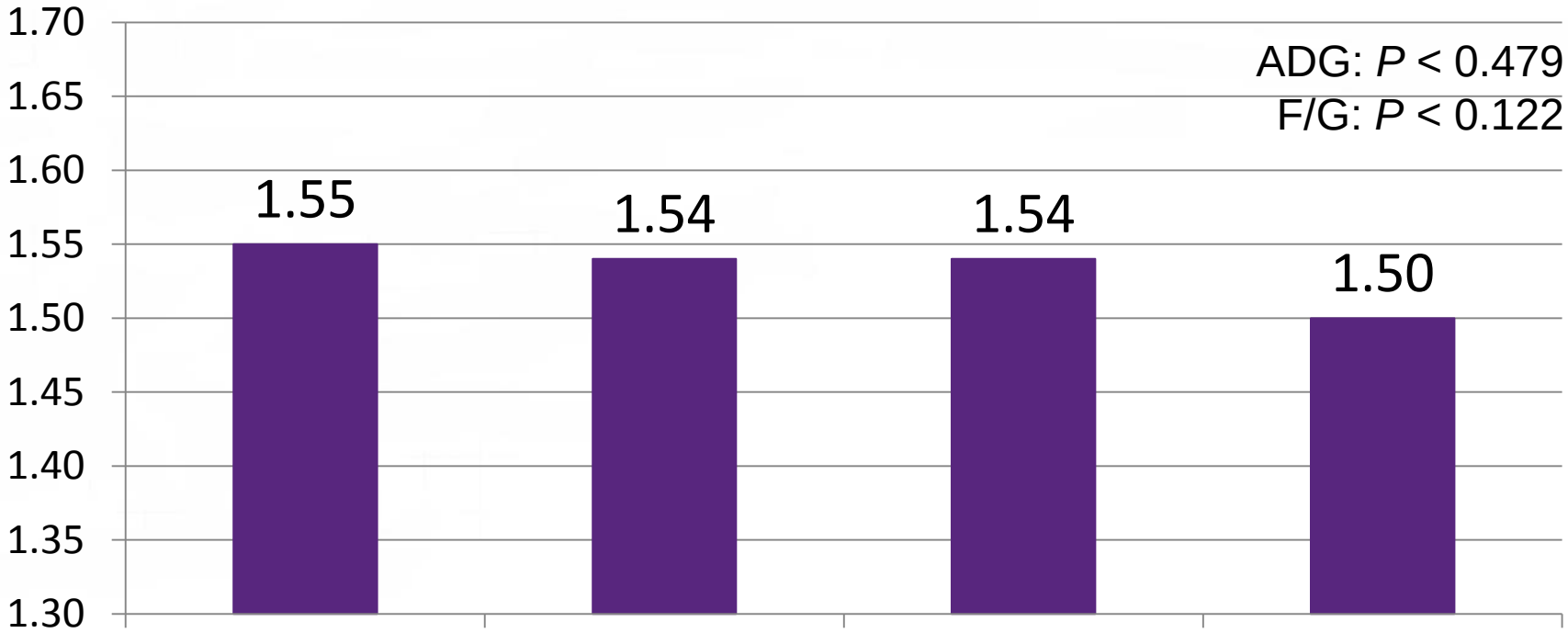


De Jong et al., 2015

Effects of Grinding Corn through a 2-, 3-, or 4-High Roller Mill on Milling Characteristics and Pig Performance



Influence of roller mill configuration on F/G of 25-50 lb pigs

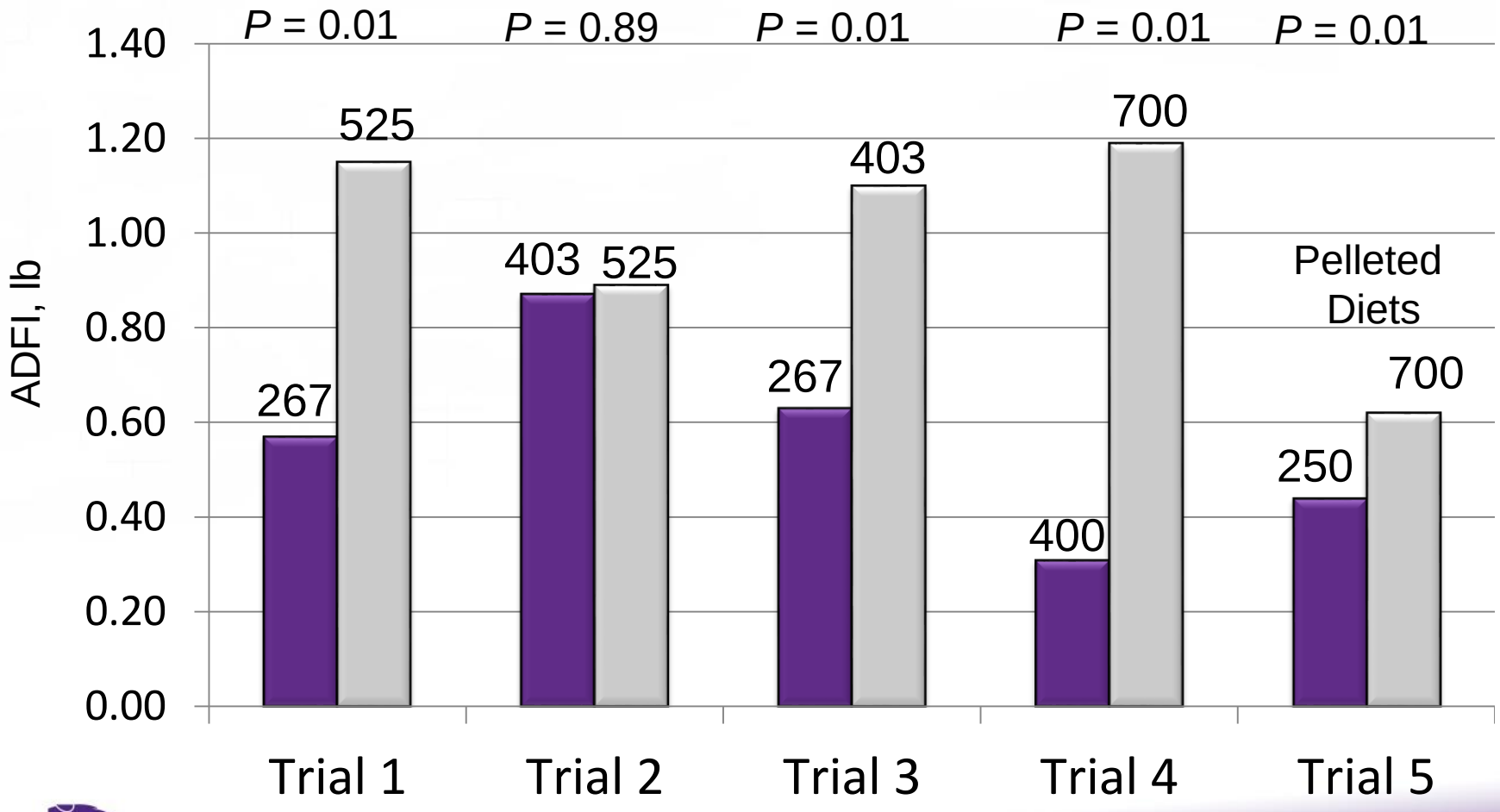


Rolls	2	3	4-Fine	4-Course
Particle Size	525	394	267	403
Std. Dev.	3.14	2.73	2.57	2.81

Gebhardt et al., 2015

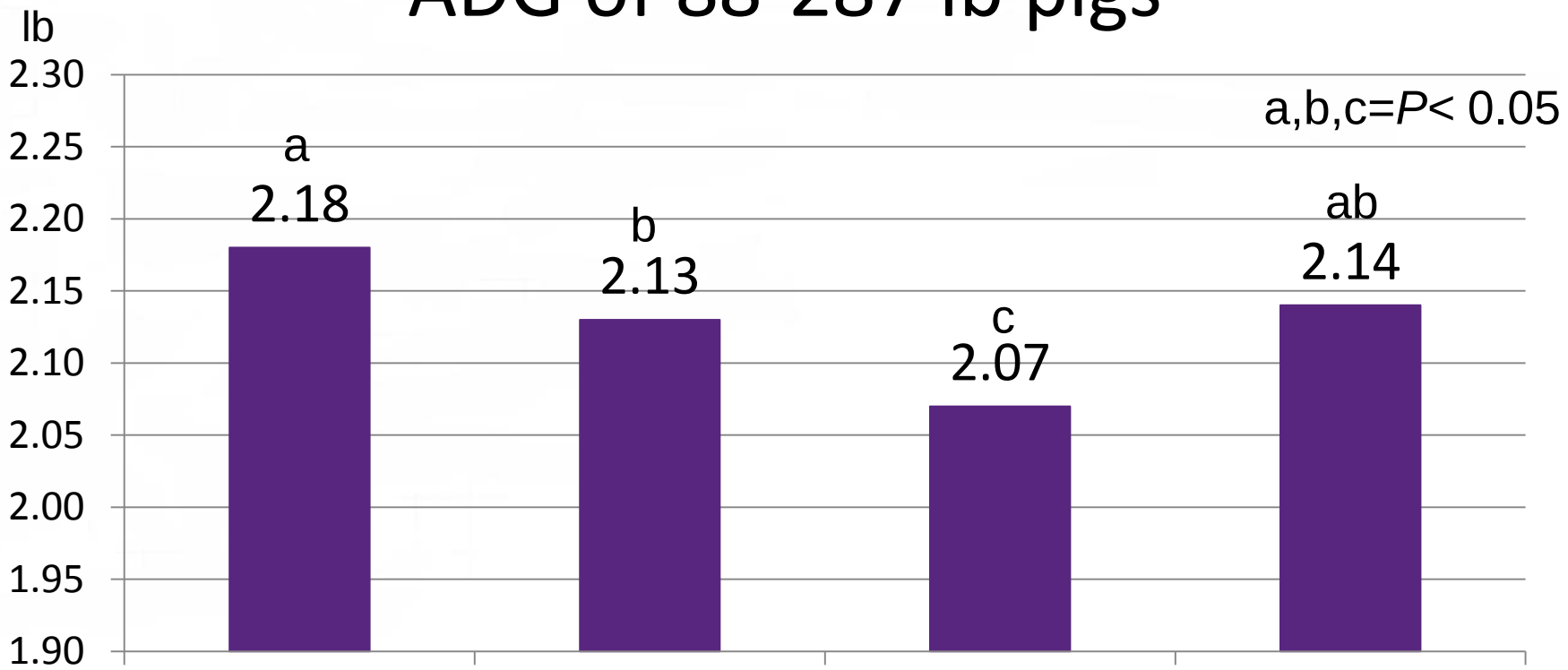
Corn particle size affects feed preference of nursery pigs

Particle size (µm) of corn is noted above columns



De Jong et al., 2013; Gebhardt, 2015; Bokelman, 2015

Influence of roller mill configuration on ADG of 88-287 lb pigs



Rolls	2	3	4-Fine	4-Course
Particle Size	572	484	295	382
Std. Dev.	3.02	2.94	2.55	2.95

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Gebhardt et al., 2015

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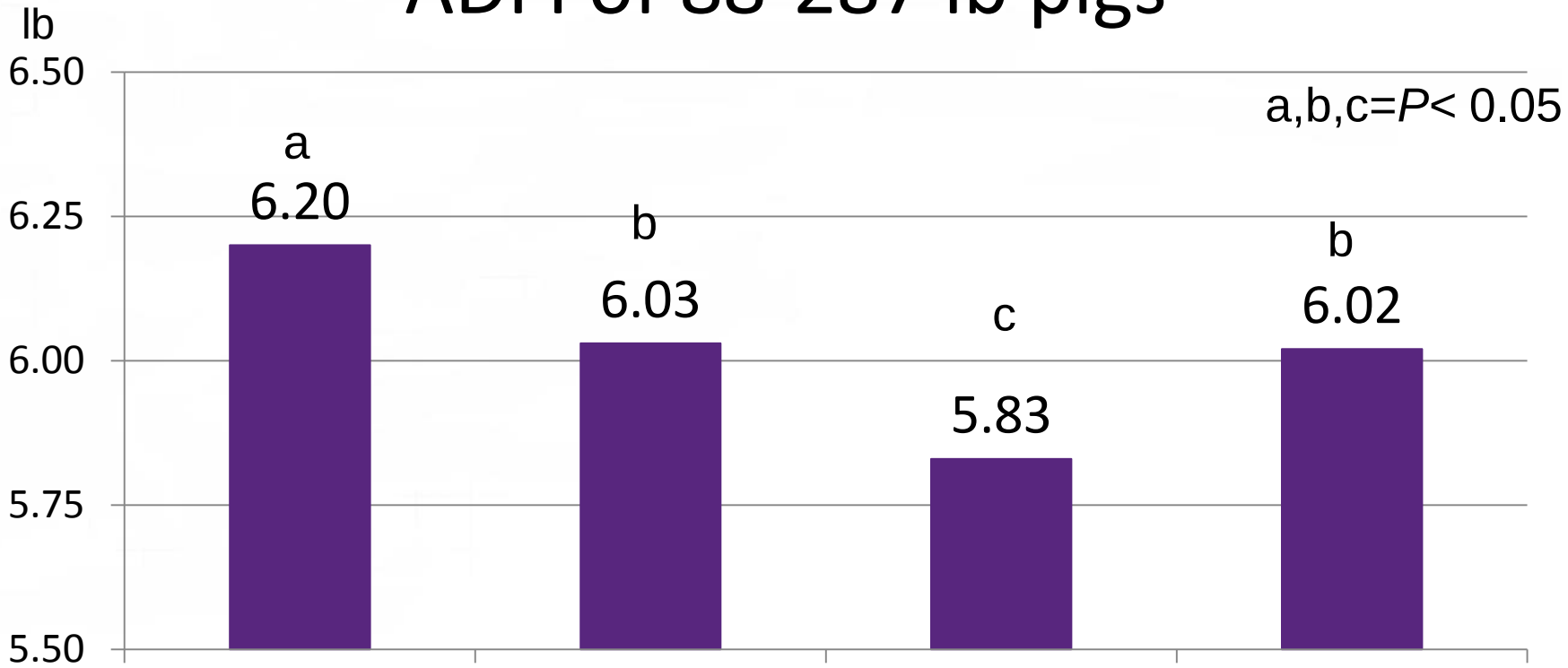
Influence of roller mill configuration on ADFI of 88-287 lb pigs



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Gebhardt et al., 2015

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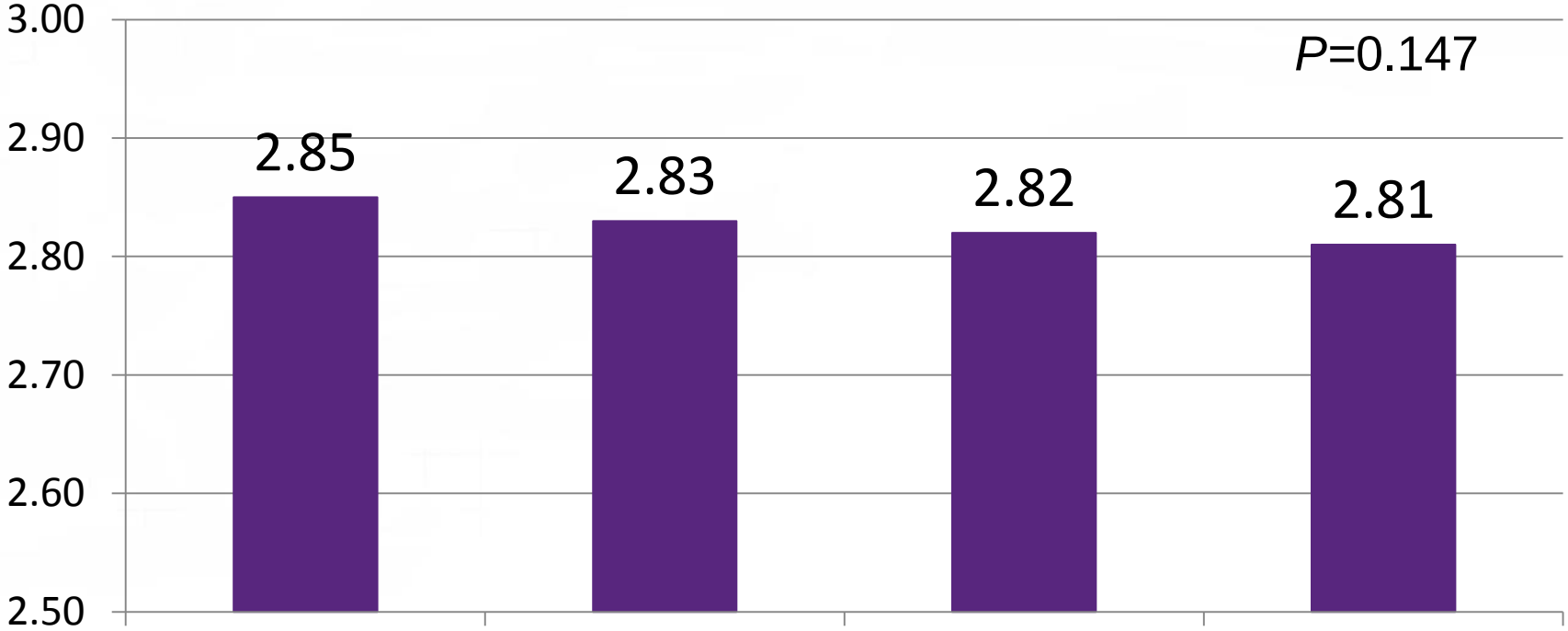
Influence of roller mill configuration on F/G of 88-287 lb pigs



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Gebhardt et al., 2015

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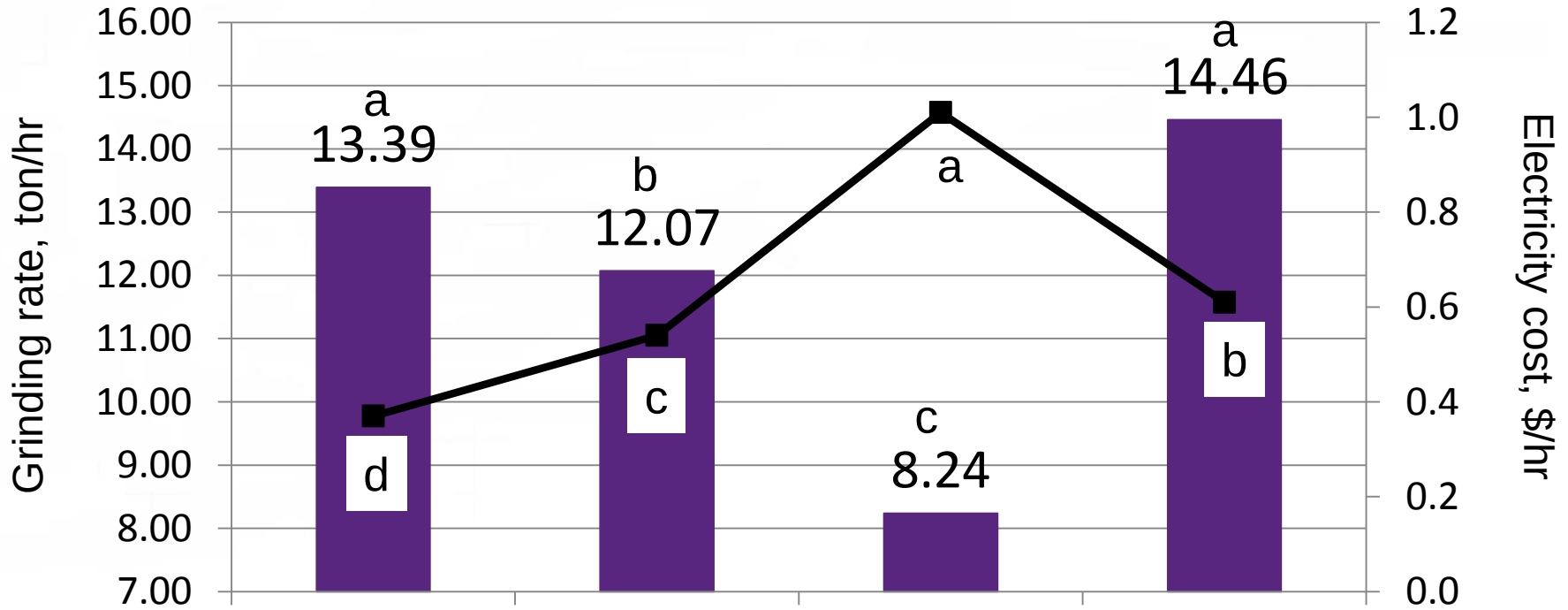
Influence of roller mill configuration on mill performance of 88-287 lb pigs



Rolls	2	3	4-Fine	4-Course
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Gebhardt et al., 2015

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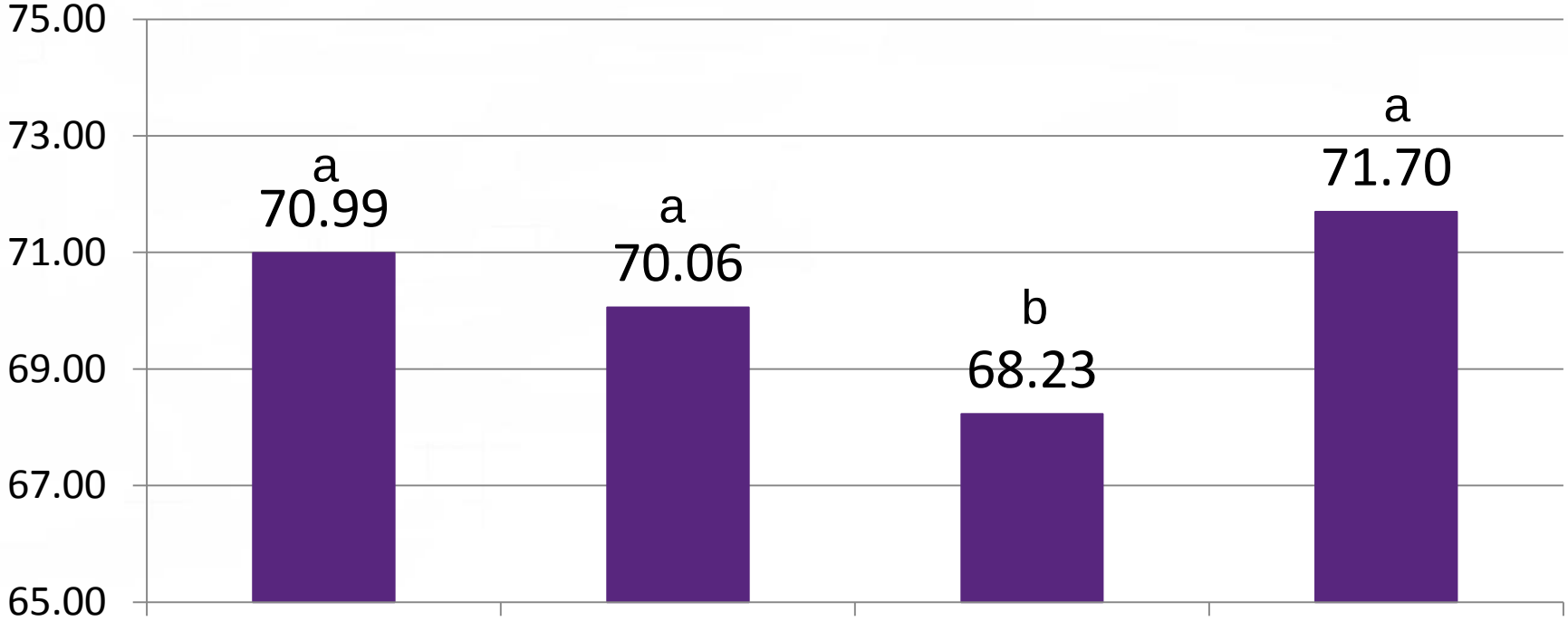
Influence of roller mill configuration on IOFC of 88-287 lb pigs



Rolls	2	3	4-Fine	4-Course
Particle Size	572	484	295	382
Std. Dev.	3.02	2.94	2.55	2.95

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Gebhardt et al., 2015

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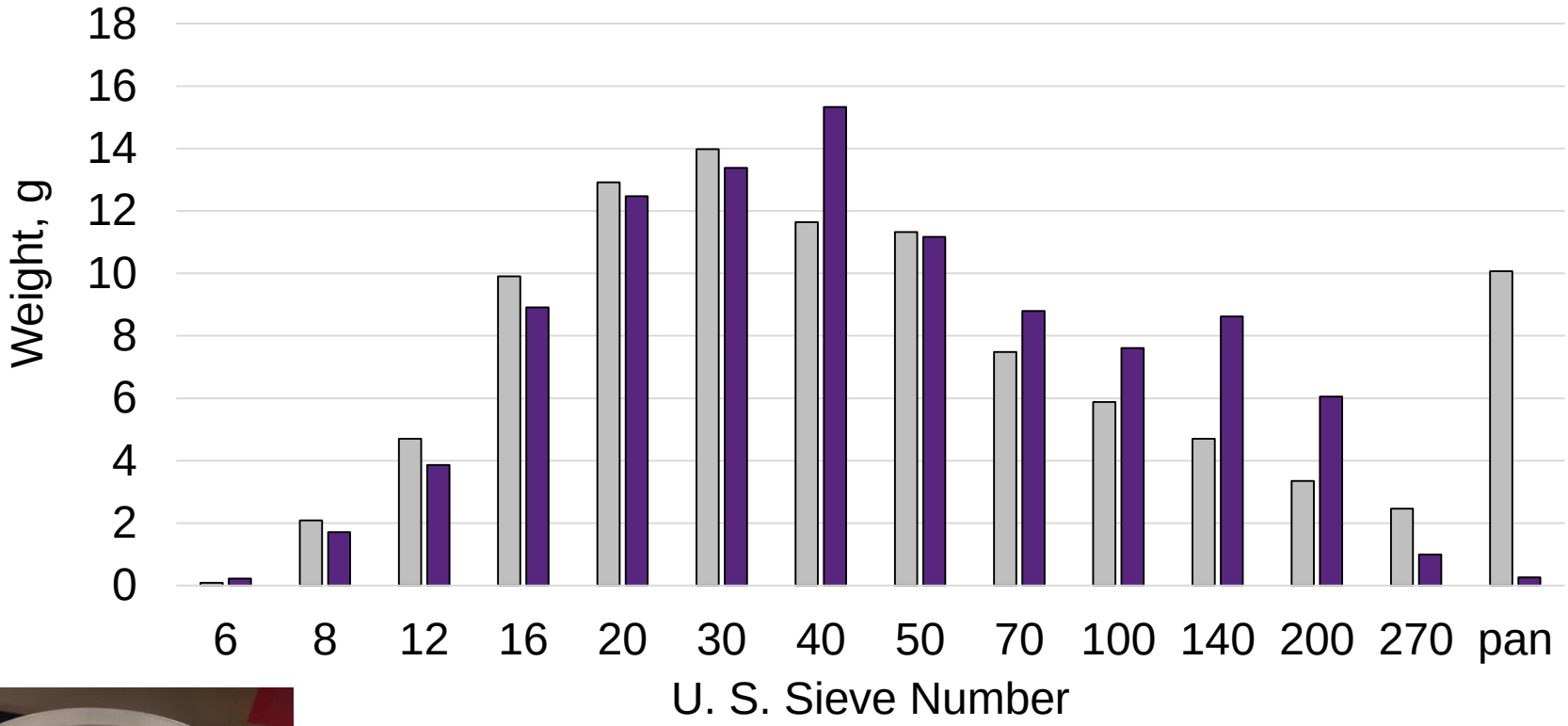
Example sample of corn analyzed with or without flow agent



Kalivoda et al., 2015

What is the influence of shake time, sieve agitators, or flow agent?

Time, min	**10**	**10**	**15**	**15**	**15**
Agitator	**Yes**	**Yes**	**No**	**Yes**	**Yes**
Flow agent	**No**	**Yes**	**No**	**No**	**Yes**

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Kalivoda et al., 2015

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K-State Particle Size Procedures

- We will change our procedures to determine particle size:
  - **Include flow agent (0.5 g fumed silica)**
  - Same sieves and agitators
  - Same 10 minute shake time

- **Results will have a lower mean particle size and a higher standard deviation**

Summary of Feed Processing Research

- Pelleting improved G:F at expense of ulcers, removals
  - Rotating provided intermediate G:F, fewer removals than pellets alone
- Little benefit to fine grinding in nursery pig diets
- Fine grinding in finishing no benefit F/G or IOFC
- Flow agent improves particle size analysis
  - Future K-State results will be conducted using flow agent
  - Lower mean particle size and higher standard deviation