The effects of adding a combination of benzoic acid, a coated sodium butyrate, and phosphoric acid to nursery diets, either with or without high levels of zinc or copper, on post-weaning pig performance

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HEALTH · NUTRITION · MATERIALS

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Trace Mineral Background

- The beginning of high levels of zinc
  - Hahn and Baker, 1993. Growth and plasma zinc responses of young pigs fed pharmacologic levels of zinc.
  - O'Quinn, P.R., J.R. Bergstrom, J.L. Nelssen, M.D. Tokach, S.S. Dritz, R.D. Goodband, C.J. Maxwell, C.A. Civis, and J.A. Loughmiller. 1997. The interactive effects among diet complexity, zinc oxide, and feed grade antibiotic on performance of segregated early-weaned pigs. Kansas Swine Industry Day Report of Progress 795.
  - Smith II, J.W., J.D. Arthington, M.D. Tokach, F. Blecha, R.D. Goodband, J.L. Nelssen, B.T. Richert, K.Q. Owen, J.R. Bergstrom, and W.B. Nessmith, Jr. 1995. The effects of dietary mineral regimen on starter pig growth performance and blood and immune parameters. Kansas Swine Industry Day Report of Progress 746.

- Alternative Trace Mineral Sources
  - Bradley, 2010. Dissertation: The efficacy of organic trace mineral supplementation to developing gilts and reproductive sows on reproduction efficiency, lameness, and longevity.

- Superdosing Phytase
  - Bradley, C. L., C. L. Walk, G. Cordero, and P. Wilcock. 2014. Pharmacological ZnO dose and superdoses of phytase on piglet growth performance and cost of gain from d 0 to 21 post-weaning. Midwest Animal Science Meetings Proceedings.
  - Bradley, C.L., C. L. Walk, N. D. Walker, and P. Wilcock. 2015. The effect of Superdosing phytase with or without the addition of live yeast in diets void of spray dried plasma in pigs from weaning to 21 days post-weaning. Midwest Animal Science Proceedings.
  - Cordero, G.; C. L. Bradley, P. Wilcock. 2017. To determine the effect of superdosing phytase on nursery pig performance, zinc, and copper blood serum levels when fed varying levels of copper supplementation.

Organic Acid Background

- Benzoic Acid – in combination with enzymes
  - Le Thanh, et al, 2018. Displayed a significant reduction in post-weaning diarrhea compared to the PC and NC diets in week 2 post-weaning.

- Sodium Butyrate – in combination with benzoic acid
  - Bottoms, K. A.; T. Tsai, C. V. Maxwell, H. H. Stein, L. Blavi, H. Maxwell, J. Knapp, C. L. Bradley. 2019. Effect of sodium butyrate on growth performance and complete blood cell count in nursery pigs: Two facility study. Midwest Animal Science Proceedings. (Thesis Work)

Materials & Methods

- Commercial Nursery Research Facility
  - 448 weaned pigs (6.44 ± 0.03 kg; PIC genetics)
  - 10 pigs/pen; 12 pens/treatment
    - Water-cup; Dry feeder; ad libitum access
- 42 d trial; 3 dietary phases
  - Phase 1: 0-7 d
  - Phase 2: 7-21 d
  - Phase 3: 21-42 d
- Dietary Treatments
  - PC: PH1: 3,000/PH2: 2,000 mg/kg Zinc Oxide/ PH3: Cu 250 mg/kg
  - NC: 150 mg/kg Zn; 13 mg/kg Cu
  - PC + Organic Acid Premix (PH 1-2: 0.9%; PH 3: 0.45%)
  - NC + Organic Acid Premix (PH 1-2: 0.9%; PH 3: 0.45%)

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Materials & Methods

- Measurements
  - Individual BW at weaning and then pen weights weekly
  - Pen feed consumption
  - Removals (date, weight, reason)
  - Individual and Group treatments
  - ADG, ADFI, FCR calculated by phase, Phase 1-2, and overall
  - Mortality and Morbidity (M+M) for overall.

- Statistics
  - The Fit Model (Mixed Linear Model) of JMP 14.0.0 (SAS, Cary, NC)
  - Main effect was dietary treatment.
  - Fixed effects were room, block and the experimental unit (random) was the pen.
  - If main effect were significant, least square means were separated utilizing Tukey's test ($P < 0.05$).

PC and NC Diets

	Phase 1		Phase 2		Phase 3	
Ingredient, %	**PC**	**NC**	**PC**	**NC**	**PC**	**NC**
Corn	42.23	42.65	55.17	55.45	63.62	63.72
Soybean Meal	23.75	23.75	27.40	27.38	30.90	30.90
Dried Whey	21.41	21.41	9.42	9.42	0.00	0.00
Spray Dried Plasma	4.00	4.00	0.00	0.00	0.00	0.00
Dried Cheese By-Product	2.76	2.74	0.00	0.00	0.00	0.00
Fish Meal	2.55	2.55	3.25	3.25	0.00	0.00
Tallow	1.00	1.00	2.00	2.00	2.00	2.00
Calcium Carbonate	0.76	0.76	0.72	0.72	0.79	0.79
Monocalcium Phosphate	0.00	0.00	0.00	0.00	0.60	0.60
Other[1]	1.07	1.06	1.69	1.69	1.94	1.94
Hiphos 2500 GT[2]	0.08	0.08	0.08	0.08	0.06	0.06
Copper Sulfate	**0.00**	**0.00**	**0.00**	**0.00**	**0.09**	**0.00**
Zinc Oxide, 72%	**0.40**	**0.00**	**0.26**	**0.00**	**0.00**	**0.00**
Total	100.00	100.00	100.00	100.00	100.00	100.00

[1] Other contained: salt, vitamins, trace minerals, amino acids, and pellet binder (Phase 2 and 3).

[2] Full Matrix for P, Ca, AA, and energy used.

PC and NC Diets

	Phase 1		Phase 2		Phase 3	
Nutrients, %	**PC**	**NC**	**PC**	**NC**	**PC**	**NC**
Crude Protein, %	23.00	23.00	20.80	20.80	20.00	20.00
Crude Fat, %	3.90	3.90	4.70	4.70	4.70	4.70
Crude Fiber, %	2.20	2.20	2.70	2.70	3.10	3.10
ME Swine[1], kcal/kg	3,439	3,452	3,419	3,428	3,389	3,392
Lactose, %	15.0	15.0	6.5	6.5	0.0	0.0
Total Lysine[1], %	1.67	1.67	1.48	1.48	1.37	1.37
SID Lysine, %	1.52	1.52	1.35	1.35	1.25	1.25
Total Calcium[1], %	0.69	0.69	0.63	0.63	0.55	0.55
Total Phosphorus[1], %	0.61	0.61	0.51	0.51	0.51	0.51
Added Zinc, ppm	**3,000**	**95**	**2,000**	**95**	**95**	**95**
Added Copper, ppm	**13.6**	**13.6**	**13.6**	**13.6**	**250.0**	**13.6**

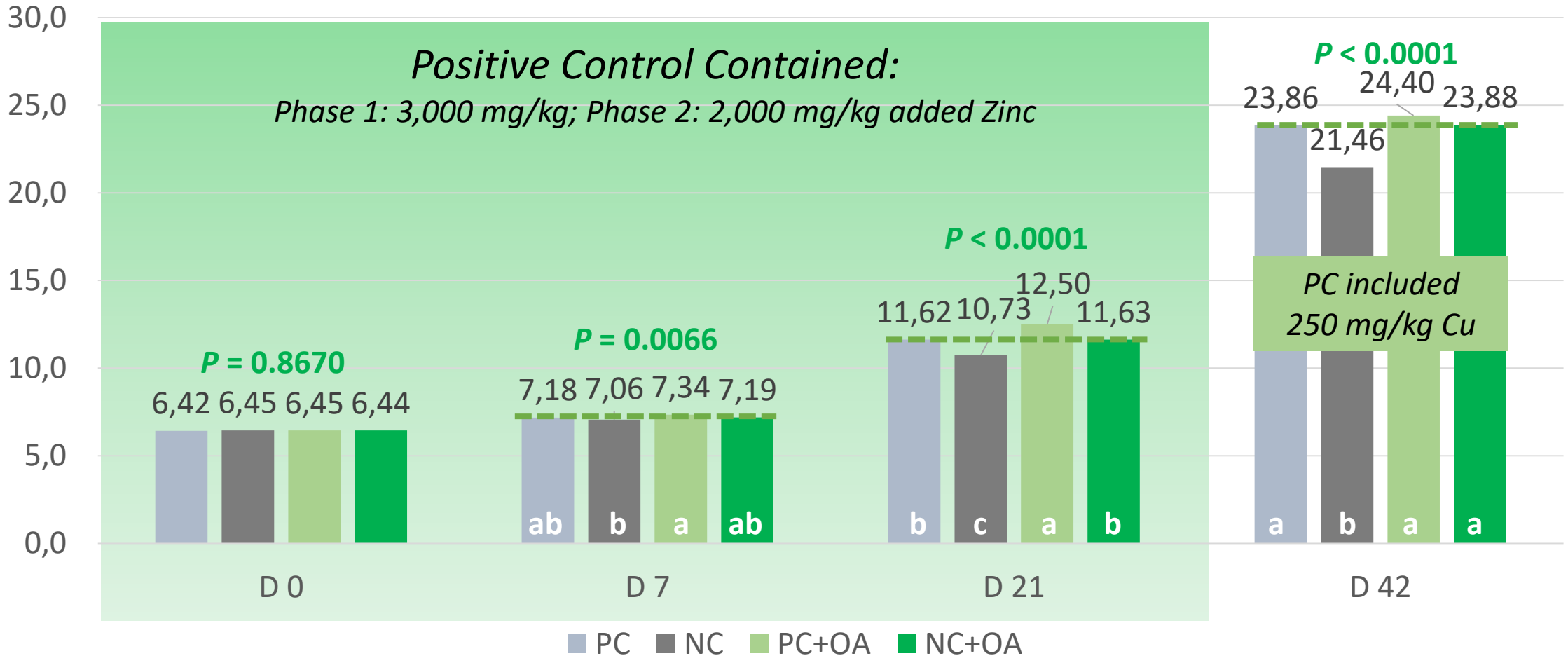
[1] Total values do not include the nutrient credit of the phytase matrix.

Organic Acid Premix

Final Concentration in Complete Diet		
Active Ingredient[1]	**Phase 1&2**	**Phase 3**
Benzoic Acid Product[2]	0.50%	0.25%
Sodium Butyrate Product[3]	0.10%	0.05%
Phosphoric Acid Product[4]	0.05%	0.025%

1. Active ingredient included in final diet. Premix was included at 0.9% in Phase 1 and 2 and then at 0.45% in Phase 3.
2. Benzoic Acid – VevoVitall (DSM Nutritional Products)
3. Sodium Butyrate – VilliMax (DSM Nutritional Products NA)
   - Product Contains: 70% Sodium Butyrate; 14.52% Lauric Acid (C12:0)
4. Phosphoric Acid – Luctacid HC (Lucta)
   - Contained 51.5% Phosphoric Acid

Body Weight, kg



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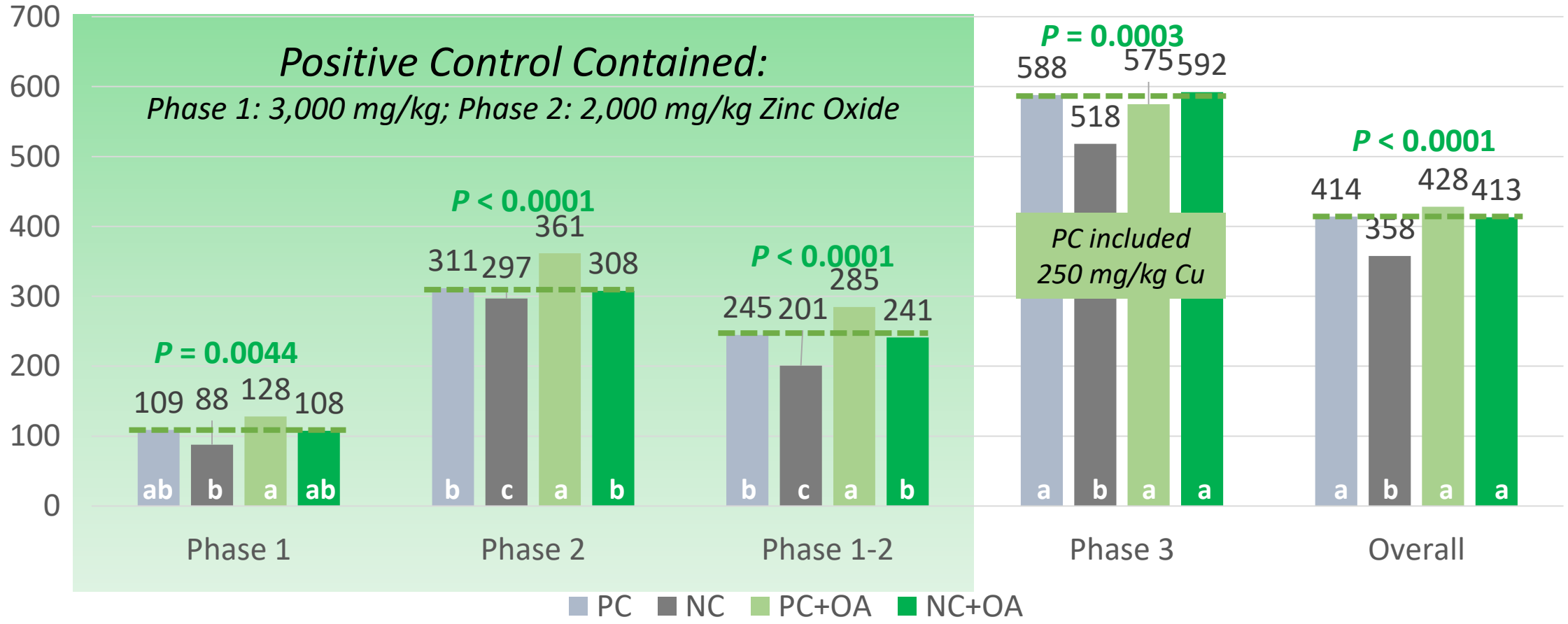
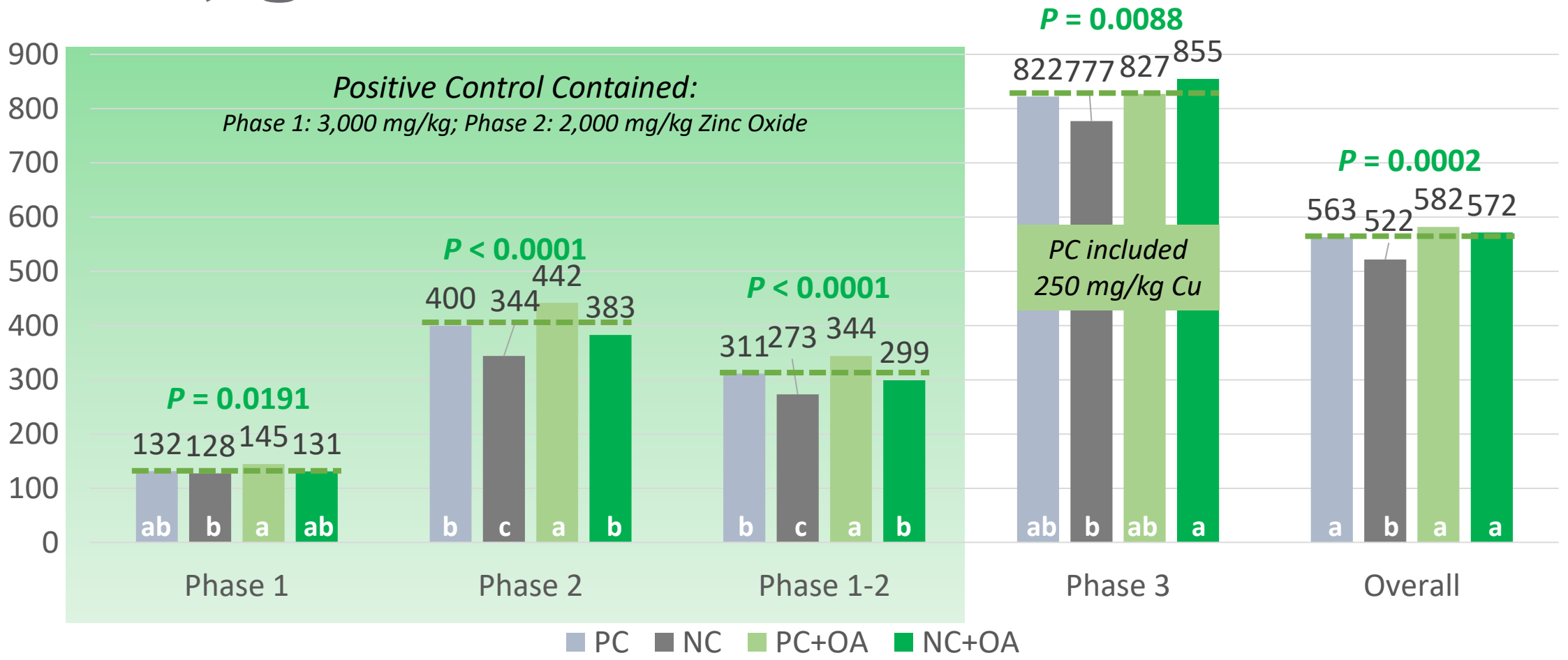
ADG, g/d



ADFI, g/d



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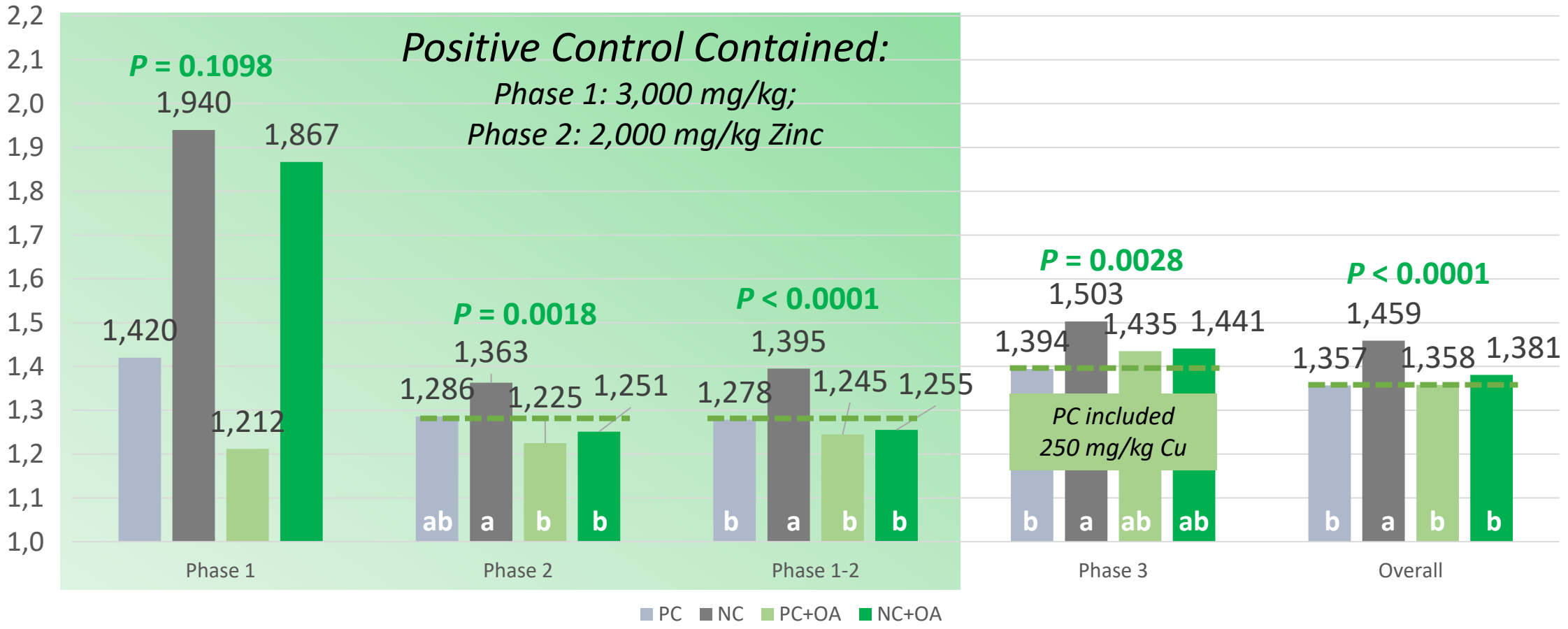
FCR



Summary - Trace Minerals

- Animal well-being
  - Mortality and Morbidity was low and not different amongst treatments
  - There were no issues of diarrhea reported or required treatment

- PC vs. NC (D 0-21) - Zinc
  - +7.7% in BW (D 21)
  - +18.0% in ADG
  - +12.2% in ADFI
  - 9.1% improvement in feed efficiency

- PC vs. NC (D 21-42) - Cu
  - +11.9% ADG
  - +7.2% in ADFI
  - 7.8% improvement in feed efficiency

Summary – Organic Acids

Positive Control + Organic Acids

- On Top of High Levels of Zinc
  - +7.5% BW at D1
  - +16.3% ADG
  - +10.5% ADFI
  - Equal FCR
- On Top of High Levels of Copper
  - No Additional Benefits

Negative Control + Organic Acids

- Zinc devoid diets (D 0-21)
  - BW = PC
  - ADG = PC
  - ADFI = PC
  - FCR = PC
- Copper devoid diets (D 21-42)
  - BW, ADG, ADFI, FCR = PC
- Overall
  - BW, ADG, ADFI, FCR = PC

➢ **Organic Acid Blends** have potential value in replacing higher levels of zinc and copper with equal performance, but also have the ability to improve growth performance in programs where higher levels of zinc are still allowed.

One Size Does NOT Fit All