



Efficacy of Celmanax™ to replace zinc oxide in nursery pig diets

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Why do nursery pigs struggle??

- Change in diet
- Insufficient gut development
- Insufficient immune development
- Poor pre-weaning performance
- Change in social environment
- Change in housing exposes them to more pathogens

Zinc mode of action

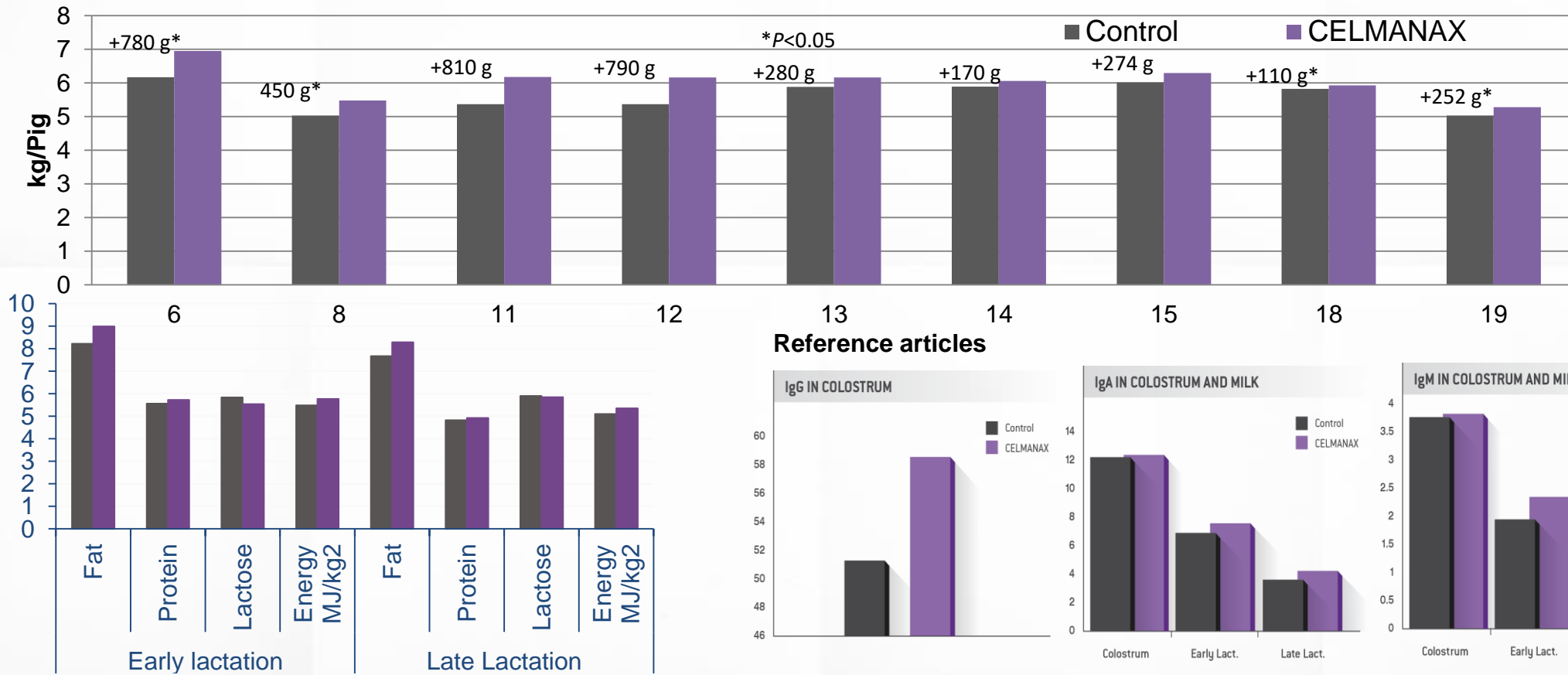
- Pharmacological levels of zinc helps
 - + development of gut morphology
 - + maintenance of gut integrity
 - + has antimicrobial activity
 - + antioxidant capacity
- Leading to improve growth performance and to reduce the susceptibility of pigs to *E. coli* infection.
- However, because of its negative effects, prudent use of pharmacological levels of zinc in swine production is needed.

The test product and its modes of action

- CELMANAX contains Refined Functional Carbohydrates (RFC) derived from enzymatic hydrolysis of yeast combined with yeast culture
- These RFCs have been previously reported to improve animal productivity by:
 - + Supports growth of beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*
 - + Bind pathogenic bacteria such as *E. coli* and *Salmonella*
 - + Support the immune system
 - + Reduce mycotoxin damage to the gut
 - + Prevent certain protozoa such as *Eimeria* and *Cryptosporidium* from attaching to the intestinal wall and causing disease

Previous Research

Composite data from nine different studies showing effect of Celmanax on piglet wean weight



- Trials consistently show sows fed CELMANAX had an average of 10% piglet body weight increase at weaning

Hung and Lindemann, 2009; Peng Ma et. al., 2013 and Thompson et. al., 2019



Our Objectives

- Does pre-weaning benefit of CELMANAX extend into the nursery phase?
- Determine the effect of Celmanax addition to nursery diets
- Compare benefit of CELMANAX verses conventional zinc oxide (ZnO) usage in the nursery.

Trial Design

- 2 x 2 x 2 factorial with seven replicates/treatment. The three treatment factors tested included:
 - 1) Celmanax (0 or 200 g/MT) in the sow lactation ration
 - 2) Celmanax (0 or 200 g/MT) in the nursery
 - 3) ZnO (0 or 2500 ppm) in the first two nursery phases
- Pigs were weaned at 18 days of age, and allotted based on initial BW and sex to mixed sex pens (n=10/pen) using a randomized complete block design
- Pigs were vaccinated for PCV2, *Mycoplasma*, *Salmonella* and Ileitis
- Pigs did not receive any creep feed prior to weaning and were *ad libitum* fed a three-phase mash nursery diet Ph1; 0-7d, Ph2; 7-21d and Ph3; 21-42d in a 42-day trial.
- BW and feed consumption by pen was recorded at each phase change and the end of the study, and used to calculate average daily gain (ADG), average daily feed intake (ADFI) and feed efficiency (FE).
- Blood samples were obtained on d 42 by venipuncture from two pigs/pen for immune gene expression analysis.
- The main effects of block, Celmanax™-sow, Celmanax™-nursery, and ZnO and their two- and three-way interactions were analyzed using General Linear Model. Least Squares Means were separated using the PDIFF option of SAS

Results: Average Daily Feed Intake

Parameter	Sow CELMANAX		Nursery Zn		Nursery CELMANAX		P-Values		
	-	+	-	+	-	+	Sow	Nursery Zn	Nursery CELMANAX
ADFI, kg/day									
0-7d	0.07	0.06	0.06	0.07	0.07	0.06	0.162	0.029	0.534
7-21d	0.34	0.37	0.32	0.38	0.36	0.35	0.002	<.0001	0.138
21-42d	1.12	1.17	1.15	1.14	1.14	1.15	0.182	0.880	0.757
0-42d	0.69	0.72	0.69	0.71	0.70	0.70	0.073	0.263	0.997

Results: Average Daily Gain

Parameter	Sow CELMANAX		Nursery Zn		Nursery CELMANAX		P-Values		
	-	+	-	+	-	+	Sow	Nursery Zn	Nursery CELMANAX
	ADG,kg/day								
0-7d	0.03	-0.01	0.00	0.02	0.01	0.01	0.0002	0.015	0.427
7-21d	0.26	0.28	0.23	0.30	0.28	0.26	0.002	<.0001	0.113
21-42d	0.54	0.55	0.55	0.54	0.55	0.54	0.119	0.534	0.203
0-42d	0.36	0.37	0.36	0.38	0.37	0.36	0.135	0.004	0.107

Although treatment effects were significant at 0-7d, that data can be inaccurate and inconsistent

Results: Feed Efficiency

Parameter	Sow		Nursery Zn		Nursery CELMANAX		P-Values		
	-	+	-	+	-	+	Sow	Nursery Zn	Nursery CELMANAX
	FE, gain/feed								
0-7d	0.29	-0.33	-0.15	0.11	-0.01	-0.03	0.002	0.148	0.930
7-21d	0.75	0.77	0.72	0.79	0.76	0.75	0.182	<.0001	0.317
21-42d	0.48	0.48	0.48	0.48	0.49	0.47	0.758	0.842	0.437
0-42d	0.53	0.52	0.51	0.53	0.53	0.51	0.591	0.179	0.298

Results: Body Weight

Parameter	Sow CELMANAX		Nursery Zn		Nursery CELMANAX		P-Values		
	-	+	-	+	-	+	Sow	Nursery Zn	Nursery CELMANAX
BW, kg									
Start (D0)	5.91	6.33	6.12	6.11	6.12	6.12	<.0001	0.432	0.986
Phase 1 (D7)	6.11	6.27	6.11	6.26	6.21	6.16	0.034	0.037	0.457
Phase 2 (D21)	9.69	10.25	9.40	10.54	10.09	9.85	0.002	<.0001	0.156
Phase 3 (D42)	21.11	21.96	21.10	21.98	21.78	21.30	0.006	0.005	0.108

Body Weight treatment means

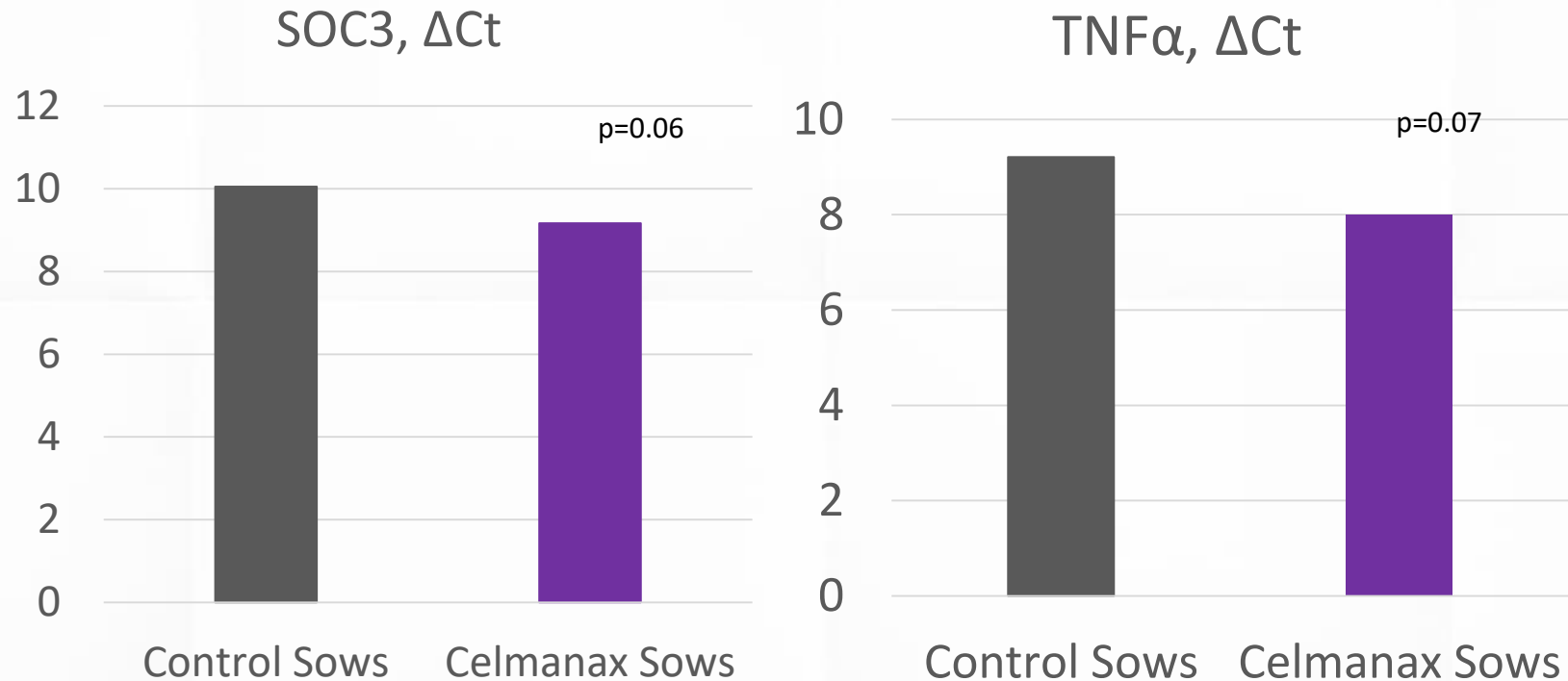
Treatments					
<u>Sow</u>	<u>Nursery</u>	BW, kg d0	BW, kg d7	BW, kg d21	BW, kg d42
Control	Control	5.92 ^b	5.95	9.19 ^e	20.64 ^c
Control	ZnO	5.90 ^b	6.27	10.32 ^{abc}	21.58 ^{bc}
Control	CELMANAX	5.92 ^b	6.05	9.09 ^e	20.95 ^{bc}
CELMANAX	Control	6.32 ^a	6.26	9.93 ^{cd}	21.90 ^{ab}

Columns with different letters were significant at $p < 0.05$

GENE EXPRESSION

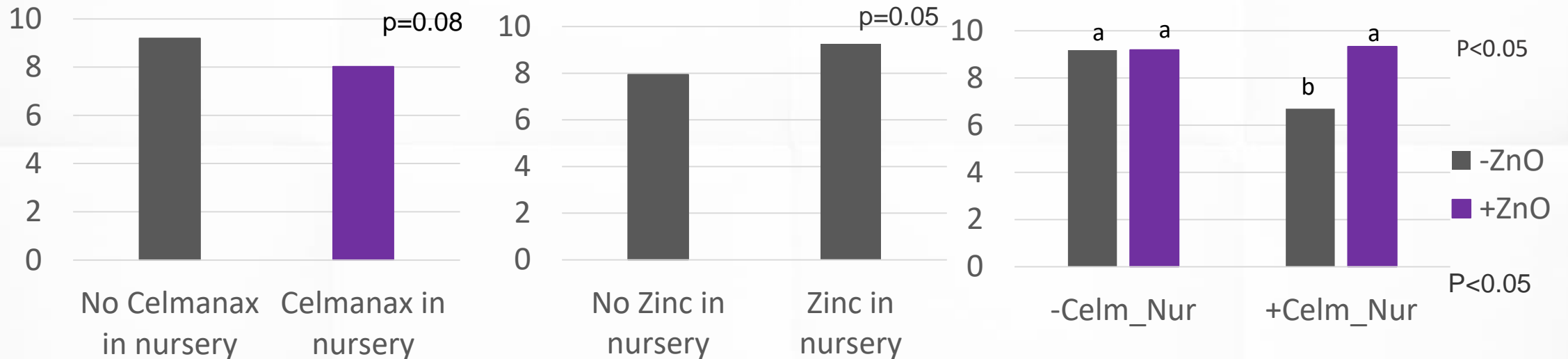
- Delta CT: Lower CT means higher gene expression

Results: Immune gene expression in sows



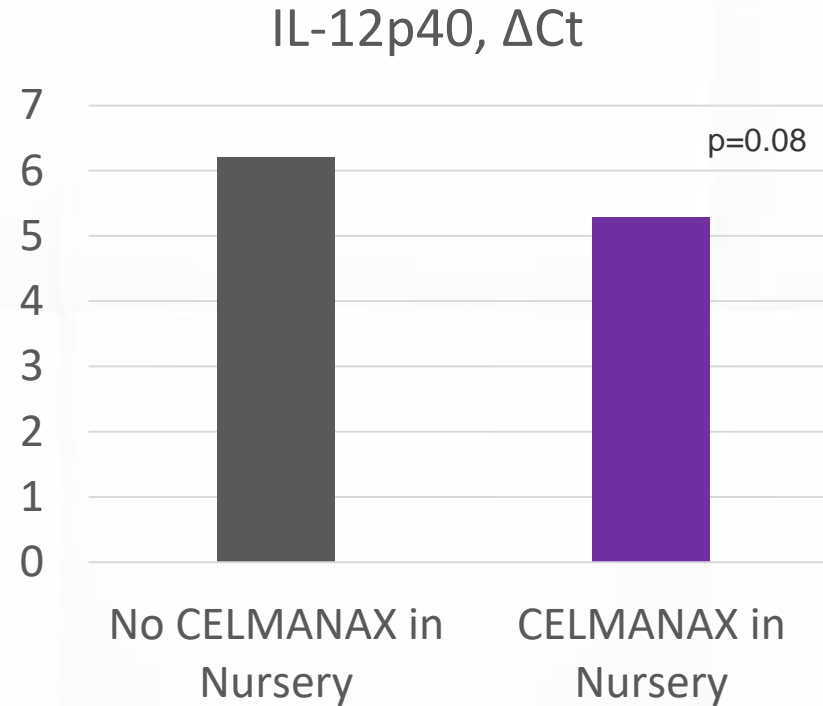
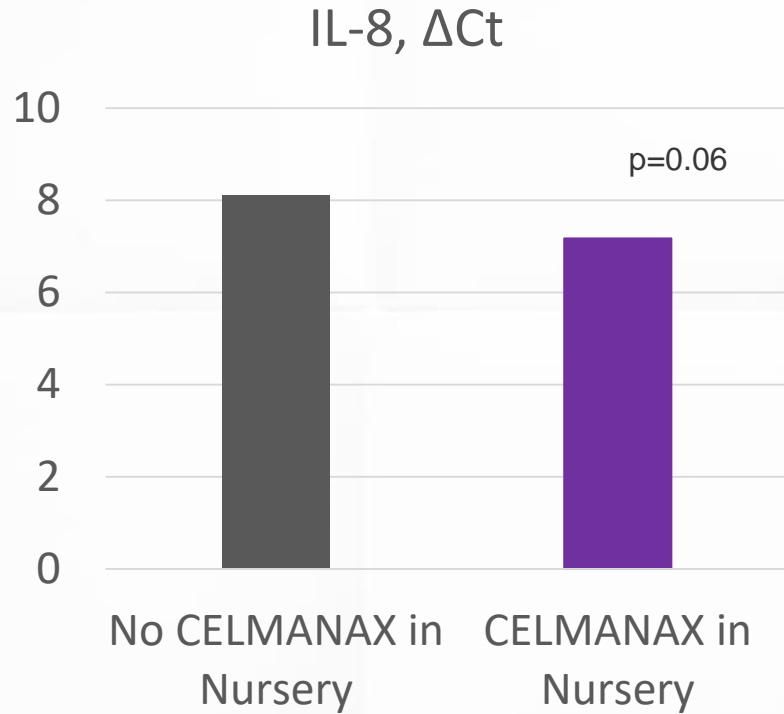
CELMANAX tends to modulate inflammatory response in sows by simultaneously upregulating expression of SOC3 and TNFα

TNF α expression in nursery, Δ Ct



- Celmanax supplementation increased TNF α expression while Zinc decreased TNF α expression
- ZnO ameliorated the inflammatory effects of Celmanax, restoring the inflammatory effect similar to that observed in control pigs.

Effect of CELMANAX on additional inflammatory factors in nursery pigs



Celmanax fed to nursery pigs enhanced the gene expression of inflammatory factors IL-8, and IL-12p40

Results summary

- Piglets from CELMANAX sows had finishing nursery weights that were not different from piglets on ZnO
- No significant differences were detected for average daily feed intake (ADFI) or feed efficiency (FE, gain/feed) over the 42-day period.
- CELMANAX tends to modulate inflammatory response in sows by simultaneously upregulating expression of SOC3 and TNF α
- Celmanax increased TNF α expression while Zinc decreased TNF α expression when fed to nursery pigs
- Celmanax fed to nursery pigs enhanced the gene expression of inflammatory factors, IL-8, and IL-12p40

Discussion

- Both Celmanax (to sows) or Zinc supplementation improved ADG and ADFI during phase 1 and 2 of nursery leading to overall BW gain at the end of nursery phase.
- However the immune response generated by Celmanax was different from Zinc. Celmanax seems to upregulate inflammatory response while Zinc seems to downregulate it.
- Is the inflammatory response generated by CELMANAX a protective mechanism for the pigs to cope with challenges faced during nursery phase?
- Does Celmanax supplementation to sow during lactation promote early maturation of immune development in nursery pigs??
- Would CELMANAX dose optimization studies in nursery phase build on the CELMANAX pre-weaning BW response to give even a greater nursery response?

Conclusions

- Similar nursery pig performance can be achieved as with the addition of pharmacological zinc if CELMANAX is fed to sows in the lactation phase.

Acknowledgements

- Robin Thompson at Carthage Innovative Swine Solutions, IL. USA
- Dr. Jeff Chewing at Swine Research Services, AR, USA



Thank You!



We're a global, multi-species, animal nutrition team.

We use scientific research to unlock the power of nature to create products that focus on your **Animals First. Productivity Always.** To learn more about CELMANAX™ contact your nutritionist, veterinarian or Arm & Hammer Animal Nutrition representative or visit AHAnimalNutrition.com.



Appendix 1: Diet Formulations

	Phase 1	Phase 2	Phase 3
	Basal	Basal	Basal
Ingredients	(%)	(%)	(%)
Corn	36.070%	38.529%	45.669%
SBM	15.556%	24.747%	28.900%
DDGs	5.051%	15.152%	20.000%
Poultry Fat	2.525%	2.525%	2.500%
Limestone	0.641%	0.985%	1.175%
Monocalcium P	0.000%	0.000%	0.210%
Salt	0.253%	0.354%	0.500%
L-Lysine	0.303%	0.369%	0.412%
DL-Methionine	0.177%	0.144%	0.108%
L-Threonine	0.071%	0.070%	0.074%
L-Tryptophan	0.016%	0.010%	0.008%
KSU Mineral PMX	0.152%	0.152%	0.150%
KSU Vitamin PMX	0.253%	0.253%	0.250%
Plasma (AP-920)	3.535%	1.515%	0.000%
Fish Meal, Menhaden	6.566%	3.030%	0.000%
Milk, Whey Powder	25.253%	12.121%	0.000%
Ronozyme P CT	0.015%	0.015%	0.015%
Ethoxiquin (Quinguard)	0.030%	0.030%	0.030%
Milk, Lactose	3.535%	0.000%	0.000%
Total	100.000%	100.000%	100.000%

	Phase 1	Phase 2	Phase 3
	Basal	Basal	Basal
Ingredients	(%)	(%)	(%)
Calculated Nutrient Levels			
NSNG ME (kcal/kg)	3489.82	3447.65	3413.59
CP (%)	21.93	24.02	23.64
Crude fat(%)	5.31	5.97	6.31
NDF(%)	6.13	10.15	12.63
ADF(%)	2.47	4.22	5.25
Total Lysine (%)	1.60	1.60	1.47
SID Lysine (%)	1.46	1.42	1.28
SID Met (%)	0.52	0.50	0.44
SID Cys (%)	0.33	0.33	0.30
SID M+C (%)	0.85	0.82	0.74
SID Threonine (%)	0.88	0.85	0.77
SID Tryptophan (%)	0.26	0.26	0.23
SID Isoleucine (%)	0.82	0.86	0.82
SID Valine (%)	0.95	0.97	0.91
Total P (%)	0.66	0.56	0.49
Available P (%)	0.46	0.32	0.23
Aval. P (%) with phytase	0.55	0.42	0.32
Ca (%)	0.85	0.75	0.65
Na (%)	0.49	0.38	0.29
Lactose	21.55	8.75	0.00

Appendix 2: Pig removals

	Celmanax	Celmanax	ZnO	
Tmts	Sow	Nursery	Nursery phase 1 & 2 Only	Mortality
1-	-	-	-	4
2-	-	-	+	1
3-	+	+	-	5
4-	+	+	+	3
5+	-	-	-	2
6+	-	-	+	2
7+	+	+	-	4
8+	+	+	+	1