**Actigen™ improves growth efficiency and immune responses in pigs experimentally infected with PRRS virus**

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**Introduction**
- Mannan-containing products have been shown to affect innate and adaptive immunity in animals. Different products may have diverse immunomodulatory effects.
- Evaluation of effects of Actigen™ (ACT, a refined yeast-based mannan preparation, Altech, Inc.) on immune responses of pigs under disease-challenged conditions is needed.

**Objective**
- To test whether feeding ACT alters immune responses in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV).

**Materials and Methods**

**Animals, experimental design, & feeding:**
- 64 pigs (n = 32 gilts and 32 barrows), 21 d old, free of PRRSV,
- RCB, 2 x 2 factorial arrangement, blocks (initial BW within sex),
- Factors: diet (control & 0.04% ACT), PRRSV (with & without),
- 4-phase feeding program with declining diet complexity

**Summary**
- Infection with PRRSV decreased pig performance.
- PRRSV increased rectal temperature (d 3 to 10 PI).
- PRRSV increased lymphocytes (d 7 & 42 PI) and neutrophils (d 7 PI), but decreased macrophages (d 7 PI).
- PRRSV increased subsets of lymphocytes and T cells.
- ACT enhanced feed efficiency (d 28 to 42 PI) and PRRSV-specific antibodies in infected pigs (d 35 PI).
- ACT increased rectal temperature.
- ACT increased leukocytes, lymphocytes, and neutrophils in infected pigs (d 7 PI).
- ACT increased subsets of lymphocytes and T cells in infected pigs (d 7 PI).

**Conclusion**
- These findings confirm that Actigen™ strengthens immune response and efficiency in the face of a PRRSV challenge.

**Acknowledgments**
- The authors gratefully thank Altech, Inc. for supporting this research.

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**Experimental procedures:**

**Measurements:**
- Pig performance: ADG, ADFI, and GF.
- Rectal temperature (RT) at d 0, 3, 7 postinoculation (PI) and weekly until d 42 PI.
- Viremia and antibodies in serum: at d 28, 0, 7, 21, and 35 PI.
- Bronchoalveolar lavage (BAL) cells: at d 7 and 42 PI, flow cytometry technique.

**Statistical analysis:**
- RCBD, using MIXED procedure of SAS, pigs as experimental units.
- Rectal temperature: repeated measures.

**Results**

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**Table 1. Effects of Actigen™ and PRRSV on subpopulations of lymphocytes and T cells in BAL of pigs at d 7 PI**

<table>
<thead>
<tr>
<th>Cells in BAL</th>
<th>Treatments (n = 8)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphocytes, x10⁴/mL</td>
<td>CON ACT IACT</td>
<td>SEM</td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>22 19 42 77</td>
<td>13</td>
</tr>
<tr>
<td>B</td>
<td>4 4 8 23</td>
<td>4</td>
</tr>
<tr>
<td>Natural killer</td>
<td>10 9 18 43</td>
<td>5</td>
</tr>
</tbody>
</table>

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**Table 2. Effects of Actigen™ and PRRSV on subpopulations of lymphocytes and T cells in BAL of pigs at d 42 PI**

<table>
<thead>
<tr>
<th>Cells in BAL</th>
<th>Treatments (n = 8)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphocytes, x10⁴/mL</td>
<td>CON ACT IACT</td>
<td>SEM</td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>121 133 394 529</td>
<td>89</td>
</tr>
<tr>
<td>B</td>
<td>13 16 46 42</td>
<td>9</td>
</tr>
<tr>
<td>Natural killer</td>
<td>44 54 165 192</td>
<td>31</td>
</tr>
</tbody>
</table>

---

**Figure 1. Effects of Actigen™ and PRRSV on pig performance 6-wk PRRSV infection**

**Figure 2. Effects of Actigen™ and PRRSV on rectal temperature of pigs during 6-wk PRRSV infection**

**Figure 3. Effects of Actigen™ and PRRSV on differential leukocyte counts in BAL of pigs at d 7 and 42 PI**

**Figure 4. Effects of Actigen™ and PRRSV on serum viremia and PRRSV-specific antibodies of infected pigs**
Effects of Actigen™ on peripheral blood immune cells in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV)

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Introduction
Mannan-containing products have been shown to affect innate and adaptive immunity in animals. Different products may have diverse immunomodulatory effects.

Therefore, evaluation of effects of Actigen™ (ACT, a refined yeast-based mannan preparation, Alltech, Inc.) on immune responses of pigs under disease-challenged conditions is needed.

Objective
To evaluate effects of ACT on peripheral blood immune cells in pigs infected with porcine reproductive and respiratory syndrome virus (PRRSV)

Materials and Methods

Animals, experimental designs, & feeding:
• Weaned pigs (n = 64, 32 gilts and 32 barrows), 21 d old, free of PRRSV
• RCBD, 2 x 2 factorial arrangement, blocks (initial BW within sex)
• Factors: diet (control & 0.04% ACT), PRRSV (with & without)
• 4-phase feeding program with declining diet complexity

Measurement of peripheral blood immune cells:
• Differential counts, subsets of lymphocytes and T cells
• At d 0, 3, 7 postinoculation (PI) and weekly until d 42 PI
• 8 replicates per treatment, using flow cytometry technique

Statistical analysis:
• Data were analyzed as repeated measures over time using the MIXED procedure of SAS.

Results

Figures: Changes in peripheral blood immune cells in pigs fed CON or ACT diet with or without PRRSV

Summary
• The numbers of leukocyte subsets in the infected pigs markedly decreased at d 3 to 7 PI, increased at d 14 to 28 PI and started declining by d 35 PI.
• PRRSV increased the numbers of total leukocytes, neutrophils, natural killer cells and several T cell subsets as compared to Sham.
• There were significant effects of day and day x PRRSV interaction on subsets of leukocytes during the course of study.
• Dietary ACT increased the numbers of total leukocytes, B cells, cytotoxic T cells and γδ T cells as compared to the control.
• The diet x PRRSV interaction did not affect the numbers of total leukocytes or any subsets of immune cells.

Conclusion
• Feeding ACT to pigs results in increased peripheral blood leukocytes, B cells, and T cells subsets which may be beneficial, especially in bacterial co-infections.
• Changes in subpopulations of immune cells over the experimental period would be a useful index of on-going processes of PRRSV infection and for designing future treatment approaches.

Acknowledgments: The authors gratefully thank Alltech, Inc. for supporting this research.
Actigen™ increases serum levels of cytokines and haptoglobin in pigs experimentally infected with PRRS Virus

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1Department of Animal Sciences, University of Illinois, Urbana, IL, 2Animal Disease and Diagnostic Laboratory, Purdue University, West Lafayette, IN, and 3Altech Inc., Nicholasville, KY

Introduction

Mannan-containing products have been shown to affect innate and adaptive immunity in animals. Different products may have diverse immunomodulatory effects.

Therefore, evaluation of effects of Actigen™ (ACT, a refined yeast-based mannan preparation, Alltech Inc.) on immune responses of pigs under disease-challenged conditions is needed.

Objective

To determine effects of ACT on serum levels of cytokines and haptoglobin (Hp) in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV)

Materials and Methods

Animals, experimental design, & feeding:

- Weaned pigs (n = 64, 32 gilts and 32 barrows), 21 d old, free of PRRSV
- 4-phase feeding program with declining diet complexity
- Factors: diet (control & 0.04% ACT), PRRSV (with & without)
- RCBD, 2 x 2 factorial arrangement, blocks (initial BW within sex)

Animals, experimental design, & feeding:

- Factors: diet (control & 0.04% ACT), PRRSV (with & without)
- RCBD, 2 x 2 factorial arrangement, blocks (initial BW within sex)
- Weaned pigs (n = 64, 32 gilts and 32 barrows), 21 d old, free of PRRSV

Materials and Methods

Animals, experimental design, & feeding:

- Weaned pigs (n = 64, 32 gilts and 32 barrows), 21 d old, free of PRRSV
- RCBD, 2 x 2 factorial arrangement, blocks (initial BW within sex)
- Factors: diet (control & 0.04% ACT), PRRSV (with & without)
- 4-phase feeding program with declining diet complexity

Results

Fig. Serum cytokine & Hp levels in pigs fed CON or ACT diet with or without PRRSV

Summary

- PRRSV increased the levels of inflammatory mediators involved in innate, Th-1, & T-regulatory responses.
- PRRSV induced secretion of innate and Th-1 cytokines as early as d 3 PI, but anti-inflammatory mediators at later time points (d 7 or 14 PI).
- ACT enhanced IL-1β, but reduced TNF-α in pigs.
- ACT increased IL-1β, IL-12, IL-10, & Hp in infected pigs, but not in Sham. The IL-1β & IL-12 favorably promote innate and T-cell immune functions, whereas IL-10 is anti-inflammatory and capable of stimulating B cell-produced antibodies.

Conclusion

The modulation of secretion of inflammatory mediators by Actigen™ at critical time points may enhance protection against PRRSV and secondary bacterial infections.

Acknowledgments: The authors gratefully thank Alltech, Inc. for supporting this research.

Experimental procedures:

Measurement of serum inflammatory mediators:

- Tumor necrosis factor (TNF)-α, IL-1β, interferon (IFN)-γ, IL-10, IL-12, Hp
- At d 0, 3, 7 postinoculation (PI) and weekly until d 42 PI
- 8 replicates per treatment, using commercial ELISA kits

Statistical analysis:

- Data were analyzed as repeated measures over time using the MIXED procedure of SAS.
The influence of the mannan oligosaccharide Bio-Mos® on sow and piglet performance: an overview

W.H. Close, Close Consultancy, Wokingham, Berkshire, UK;

Introduction
Reviews of the literature have shown that Bio-Mos® positively influences the growth rate and feed conversion efficiency of piglets immediately post weaning (Miguel et al., 2004), as well as in the grow-finish period (Rosen, 2006). The purpose of this summary is to review all the available studies when Bio-Mos® was included in the diet of the sow and to evaluate the responses obtained.

Description of trials
In total, 12 studies have been carried out (Table 1). Data were analysed with Bio-Mos® inclusion as the main effect to determine its impact on sow and pre-weaning piglet performance.

Effect on litter size and pre-weaning mortality
Including Bio-Mos® in the diet of the sow resulted in an increase in the number of piglets born alive (11.24 ± 11.14), but the number of piglets weaned was numerically higher: 10.11 (±1.09) vs 9.67 (±0.74) (p>0.05) (Figure 1). When adjusted for differences in the numbers born alive, the increase in litter size was 0.32 (±0.34). This increase resulted from a 21.0% decrease in stillbirth rate (11.5 (±1.85) to 9.13 (±1.60) (p<0.05) (Figure 2).

Effects on birth weight and weaning weight
The inclusion of Bio-Mos® in the diet of the sow resulted in the mean birth weight increasing from 1.46 (±0.11) to 1.52 (±0.11) kg, a difference that was significant (p<0.05) in several of the studies. Across all studies, weaning weight increased from 6.87 (±1.25) to 7.17 kg, representing a 9.0% increase over the controls.

Effects on colostrum quality and quantity
In 5 studies colostrum samples were taken within the first 24 h of farrowing and the concentration of IgA, IgG and IgM analysed (Table 2).

Table 2. The effect of Bio-Mos® on colostrum quality.

<table>
<thead>
<tr>
<th>Study No</th>
<th>Country</th>
<th>No. of Sows</th>
<th>Bio-Mos application</th>
<th>IgA</th>
<th>IgG</th>
<th>IgM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 USA</td>
<td>24</td>
<td>5 g/l (14 d)</td>
<td>5 g/l (21 d)</td>
<td>3565</td>
<td>4213*</td>
<td>326</td>
</tr>
<tr>
<td>2 USA</td>
<td>1028</td>
<td>2 kg/l (21 d)</td>
<td>1 kg/l (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3 USA</td>
<td>318</td>
<td>5 g/l (21 d)</td>
<td>5 g/l (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4 Canada</td>
<td>221</td>
<td>2 kg/l (14 d)</td>
<td>2 kg/l (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5 Italy</td>
<td>480</td>
<td>1.5 kg/l (28 d)</td>
<td>1.5 kg/l (28 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6 Argentina</td>
<td>334</td>
<td>1.5 kg/l (23 d)</td>
<td>1.0 kg/l (16 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7 Spain</td>
<td>80</td>
<td>2 kg/l (14 d)</td>
<td>1 kg/l (28 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8 Hungary</td>
<td>81</td>
<td>2 kg/l (42 d)</td>
<td>1 kg/l (28 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>9 France</td>
<td>52</td>
<td>4 g/l (86 d)</td>
<td>4 g/l (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>10 Canada</td>
<td>48</td>
<td>1 kg/l (throughout gestation)</td>
<td>1 kg/l (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>11 Mexico</td>
<td>270</td>
<td>1.5 kg/l (21 d)</td>
<td>1.5 kg/l (28 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12 Poland</td>
<td>30</td>
<td>8 g/d (30 d)</td>
<td>8 g/d (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12 Poland</td>
<td>30</td>
<td>8 g/d (30 d)</td>
<td>8 g/d (21 d)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Across all studies, weaning weight increased from 6.87 (±1.25) to 7.17 kg (p>0.5); an increase of 6.0 (±2.75) kg, representing a 9.0% increase over the controls.

Overall Conclusions
The results of this review show that when Bio-Mos® is included in the diet of the sow during gestation and lactation, the following responses were recorded:
- An extra 0.32 piglets weaned per litter = 0.77 piglets/sow/year
- An improvement in piglet weaning weight of 0.30 kg
- An increase in the concentration of immunoglobulin in colostrum
- An increase in colostrum production during the first 24 h post partum
- Improved piglet growth rate in the first 24 h of life
- A ‘carry-over’ effect with higher performance of piglets post weaning
- Reduced wean-oestrus period = fewer empty days = more litters born
- A very cost-effective response with an ROI of 5.8:1

The responses to Bio-Mos® in sow diets are therefore consistent, with considerable advantages for both sow and piglet performance and hence profitability. The recommended level of inclusion of Bio-Mos® in sow diets is 1 kg/t through gestation, lactation and post weaning.

References available on request
The effect of Actigen™ on post-wean pig performance compared with an antibiotic growth promoter

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1College of Veterinary Medicine, De La Salle–Araneta University, Malabon City, Philippines; 2Kalaw Farm, Brgy Santiago, Malvar Batangas, Philippines; 3Alltech Biotechnology Corp, Muntinlupa City, Philippines; 4Alltech Biotechnology Ltd Pty., Melbourne, Australia

Introduction
Actigen™ is derived from Saccharomyces cerevisiae and designed to help animals of all species thrive and reach their genetic potential. In research trials conducted in pigs, Actigen™ was shown to be as efficacious as common antibiotic growth promoters (AGPs). However, there is still a need to verify these results in commercial settings and against different AGPs.

Objective
To compare the performance of post-wean pigs fed Actigen™ versus that of those fed the common AGP strategy, colistin + amoxicillin.

Materials and methods

Experimental design
- 120 newly weaned, Large White-Landrace x Pietrain-Duroc pigs (7.01±0.57 kg)
- Completely randomized experimental design
- 2 treatment groups
- 15 pigs/pen x 4 pens/trt
- Naturally ventilated, elevated-plastic slatted nursery
- 2 nipple drinkers/pen and a rotary automatic feeder
- Pigs exhibiting loose and watery diarrhea were injected with 1 cc/d of colistin injectable until the scours stopped.
- Management practices were the same between groups.
- Feed available ad libitum
- Feeding trial duration = 34 days

Treatments
- Control – diet with 4 kg/ton colistin-amoxicillin feed premix (amoxicillin 10% + colistin 10M IU/kg)
- Actigen™ – diet with 0.4 kg/ton Actigen™ (Alltech, Inc.)

Measurements
- Start and final weights, daily feed intake, and mortality
- Scouring % was calculated as the total number of pigs exhibiting loose and watery diarrhea within 1 to 7 d post-wean over the total number of pigs per pen. Individual pigs were counted once only during the trial.

Data analysis
- ANOVA with MS Excel Statistical Analysis Package.
- Treatment effect on scouring and mortality was analyzed using Chi-Square Goodness-of-Fit test.

Results
- Final weight, ADG and feed intake did not differ between treatments (P>0.05).
- FCR tended to be better in the Actigen™-fed pigs compared with the colistin-amoxicillin-fed pigs (P=0.07).
- Mortality % and scouring % did not differ between treatments (X² = 2.67, 0.53, respectively).
- Medication cost (injectable) was the same for both treatment groups.
- In-feed medication cost per pig was lower for the Actigen™ group compared with the colistin-amoxicillin group ($0.10 vs. $0.78, respectively).

Conclusions
Overall, performance of post-wean pigs (up to 64 d of age) was similar between the Actigen™ or colistin-amoxicillin treatments. Actigen™ was the more economical option.

| Table 1. Performance of pigs fed Actigen™ or colistin-amoxicillin treatments. |
|-----------------|-----------------|---------|---------|
|                  | Colistin-amoxicillin | Actigen™ | SEM   | P-value |
| Initial weight, kg | 7.01            | 7.01    | 0.203  | 0.99    |
| Final weight, kg  | 20.33           | 20.40   | 0.581  | 0.96    |
| ADG, g/d          | 392             | 394     | 0.015  | 0.96    |
| Average daily feed intake, g/d | 7.19 | 6.87 | 0.025 | 0.53    |
| FCR               | 1.84            | 1.75    | 0.026  | 0.07    |
| Mortality, %      | 0.00            | 3.3     | NS     |         |
| Scouring, %       | 23              | 23      | NS     |         |
| Medication cost (injectable), $/pig | 0.03 | 0.03 | NS     |         |
| Medication cost (in-feed), $/pig | 0.78 | 0.10 |         |         |

1Colistin injectable, 1 cc/pig/d; calculated as the total cost per pen divided by 15 pigs/pen and averaged for all replicates.
2Medication cost (in-feed) per pig was calculated as the average of the actual cost of in-feed medication used per replicate pen divided by the number of pigs per pen.
NS – Did not differ (P>0.05)
The effect of Allzyme® SSF on the performance of finisher pigs fed corn ear as partial replacement of corn

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1Camille Farm, Gen. Santos City, Philippines, 2Alltech Biotechnology Corp, Muntinlupa City, Philippines, 3Alltech Biotechnology Pty Ltd, Bangkok, Thailand

Introduction
In most countries cattle are fed diets with corn that is still on the cob. In the Philippines, corn prices average PhP 10–13/kg, whereas corn on the cob bought direct from the farm costs 50% less. Devegowda et al. (2007) showed that there are no deleterious effects in replacing corn with corn ear when Allzyme® SSF (Alltech Inc.) is added to layer diets.

Objective
To determine the effect of partially replacing corn with corn ear on the performance of finishing pigs from 50 kg to slaughter.

Materials and methods
Experimental design
- 336 mixed sex, LW-LR x PD pigs (49±0.95 kg)
- Complete randomized design
- 336 mixed sex, LW-LR x PD pigs (49±0.95 kg)
- 336 mixed sex, LW-LR x PD pigs (49±0.95 kg)

Treatments
- Control – Corn-soya diet
- T1 – Control (reformulated to replace corn) + 25% corn ear
- T2 – T1 + 200 g/ton Allzyme® SSF
- T3 – T1 + 400 g/ton Allzyme® SSF

Measurements
- Body weight, feed intake, ADG, FCR, feed costs.
- Proximate analysis
- Feed costs

Data analysis
- ANOVA using Statistix v9.0

Results
- Replacing corn with dried corn ear at 25% did not adversely affect growing-finishing pig performance (Table 1, Figures 1–4).
- The cost reduction by using corn ear was $20 per ton (Table 1).
- Allzyme® SSF at 200 g/ton added to diets with 25% corn ear improved (P<0.05) overall FCR by 15 pt (Table 1, Figure 4).
- Allzyme® SSF at 200 g/ton added to diets with 25% corn ear improved cost of gain by – PhP 70 per pig ($1.50) over diets with 25% corn ear.
- PhP 194 per pig ($4.22) over corn-soya diets.

Figure 1. Effect of corn ear and Allzyme® SSF on pig weight

Figure 2. Effect of corn ear and Allzyme® SSF on average daily gain

Figure 3. Effect of corn ear and Allzyme® SSF on daily feed intake

Figure 4. Effect of corn ear and Allzyme® SSF on FCR

Figure 5. Effect of corn ear and Allzyme® SSF on cost of gain

Table 1. Effect of corn ear and Allzyme® SSF on pig performance and cost.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control (corn-soya)</th>
<th>Neg Control (25% corn ear)</th>
<th>Neg Control + 200 g/ton SSF</th>
<th>Neg Control + 400 g/ton SSF</th>
<th>P value</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>49.05</td>
<td>48.94</td>
<td>49.02</td>
<td>49.04</td>
<td>0.999</td>
<td>0.268</td>
</tr>
<tr>
<td>Grower</td>
<td>80.47</td>
<td>79.41</td>
<td>80.03</td>
<td>80.13</td>
<td>0.743</td>
<td>0.311</td>
</tr>
<tr>
<td>Final</td>
<td>95.98</td>
<td>94.86</td>
<td>95.36</td>
<td>95.01</td>
<td>0.878</td>
<td>1.047</td>
</tr>
<tr>
<td>Feed intake, kg/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>1.44</td>
<td>1.41</td>
<td>1.40</td>
<td>1.44</td>
<td>0.793</td>
<td>0.035</td>
</tr>
<tr>
<td>Grower</td>
<td>2.25</td>
<td>2.31</td>
<td>2.23</td>
<td>2.22</td>
<td>0.741</td>
<td>0.059</td>
</tr>
<tr>
<td>Final</td>
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<td>2.66</td>
<td>2.63</td>
<td>2.65</td>
<td>0.938</td>
<td>0.040</td>
</tr>
<tr>
<td>Average daily gain, g/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>651</td>
<td>544</td>
<td>554</td>
<td>555</td>
<td>0.903</td>
<td>0.016</td>
</tr>
<tr>
<td>Grower</td>
<td>738</td>
<td>736</td>
<td>730</td>
<td>709</td>
<td>0.860</td>
<td>0.027</td>
</tr>
<tr>
<td>Final</td>
<td>609</td>
<td>596</td>
<td>602</td>
<td>597</td>
<td>0.947</td>
<td>0.017</td>
</tr>
<tr>
<td>FCR, g/kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>2.57</td>
<td>2.59</td>
<td>2.53</td>
<td>2.60</td>
<td>0.327</td>
<td>0.025</td>
</tr>
<tr>
<td>Grower</td>
<td>3.33</td>
<td>3.14</td>
<td>3.06</td>
<td>3.15</td>
<td>0.827</td>
<td>0.208</td>
</tr>
<tr>
<td>Final</td>
<td>2.79</td>
<td>2.79</td>
<td>2.64</td>
<td>2.72</td>
<td>0.040</td>
<td>0.034</td>
</tr>
<tr>
<td>Cost of gain, PhP/kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial</td>
<td>38.01</td>
<td>35.61</td>
<td>35.18</td>
<td>36.70</td>
<td>0.0015</td>
<td>0.337</td>
</tr>
<tr>
<td>Grower</td>
<td>45.12</td>
<td>40.06</td>
<td>39.52</td>
<td>41.56</td>
<td>0.527</td>
<td>2.815</td>
</tr>
<tr>
<td>Final</td>
<td>39.99</td>
<td>37.23</td>
<td>35.67</td>
<td>37.58</td>
<td>0.002</td>
<td>0.498</td>
</tr>
</tbody>
</table>

Conclusions
- Corn ear can replace 25% of corn in growing-finishing pig diet without adversely affecting performance.
- Adding Allzyme® SSF to diet containing 25% corn ear can further increase profit potential.
Intestinal, liver, kidney, serum and biliary Cu concentrations in piglets fed Cu proteinate or CuSO₄

Blaire Aldridge¹, Ronan Power², Karl Dawson and Scott Radcliffe¹

¹Purdue University, Animal Sciences Department, West Lafayette, IN, ²Center for Animal Nutrigenomics and Applied Animal Nutrition, Alltech Inc., Nicholasville, KY

Introduction
Understanding copper (Cu) absorption and distribution mechanisms in weanling pigs is important because it has been shown that Cu can be fed as high as 250 ppm to provide an antibiotic activity. Free Cu ions can be toxic to the weanling pig and can cause hemorrhage, liver damage, and death. Cu homeostasis is necessary because free Cu ions generated during protein turnover can damage tissues. The current requirements for Cu are set at only ~6 ppm. Copper can be fed as high as 250 ppm to provide antibiotic activity. Pigs can be fed Cu in the diet, which can improve ADG and G:F.

Materials and methods
To compare the effects of CuSO₄ and Bioplex® Cu (Alltech Inc.) when fed to weanling pigs on intestinal, liver, gall bladder, kidney and serum Cu concentrations.

Objectives
The objectives were to compare the effects of CuSO₄ and Bioplex® Cu on intestinal, liver, gall bladder, kidney and serum Cu concentrations.

Materials and methods
- 70 crossbred barrows, weaned at 20±1 d of age. Weanling pigs were fed a basal diet for 4 wks before supplementation.
- CuSO₄ or Bioplex® Cu at 0, 4, 25, or 125 ppm were supplemented to the basal diet.
- Cu concentrations were analyzed by ICP-MS (inductively coupled plasma – mass spectrometry).
- Data were analyzed in SAS: MIXED Procedure for 2x3 factorial design

Results
- Two wks of Cu supplementation was insufficient to substantially improve ADG (P=0.12) or G:F (P=0.11, data not shown).
- After 2 wks, Cu at 125 ppm from either source increased Cu concentration in the intestine (jejunal) by 11.4% increase in response to CuSO₄ supplementation on gall bladder Cu concentrations and serum (Figures 1 – 4).
- Cu SO₄ supplementation on liver Cu concentrations (dry basis) in young pigs. Values are least square means.

Conclusion
Two weeks of supplementation using either Bioplex® Cu or CuSO₄ at 125 ppm greatly increased Cu stores in intestine (jejunal), liver, kidney, and gall bladder. At this same dose, Bioplex® Cu provided an 11.8% advantage over CuSO₄ in increasing serum Cu concentration.
Effect of zinc level and source on postweaning pig performance and mineral status

J.S. Jolliff, D.C. Mahan, G.M. Hill, and J. E. Link
The Ohio State University, Columbus; Michigan State University, East Lansing

Introduction
Postweaning pigs fed unfortified corn-soybean meal diets can develop a parakeratosis-like skin condition even when calcium and phosphorus levels are otherwise adequate. Pigs have been shown to recover from the skin condition after being fed meal diets containing added trace minerals, which suggests that zinc might be the primary limiting factor in complex corn-soybean meal diets.

Objective
To re-evaluate the zinc requirement in typical pig nursery diets.

Methods
Experimental design
To re-evaluate the zinc requirement in typical pig nursery diets.

Table 1. Composition of phased diets.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Phase 1 0–10 d</th>
<th>Phase 2 10–35 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>30.23</td>
<td>25.70</td>
</tr>
<tr>
<td>Soybean meal, 48%</td>
<td>15.00</td>
<td>17.50</td>
</tr>
<tr>
<td>Soy protein concentrate</td>
<td>11.00</td>
<td>15.00</td>
</tr>
<tr>
<td>Lactose</td>
<td>20.00</td>
<td>18.00</td>
</tr>
<tr>
<td>Dried whey</td>
<td>15.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Plasma protein</td>
<td>3.00</td>
<td>-</td>
</tr>
<tr>
<td>Innate Zn: Phase 1 = 32 ppm; Phase 2 = 50 ppm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measurements
- Body weight (BW) and feed intake at 0, 10, and 35 d
- 1 pig/pen killed d 10 & d 35 postweaning
- Liver, heart, kidney sampled; organ weight (g, %BW) and Zn (total & ppm) determined.

Results
- Supplemental Zn increased growth performance:
  - Pig BW at 35 d postweaning
  - ADG for the 0 to 10, 10 to 35, & 0 to 35 d periods
  - G:F for the 0 to 10 d period
- ADG increased with increasing levels of Bioplex® Zn.
  - ADG peaked at 75 ppm for the 0 to 10 and 0 to 35 d periods.
- ADG peaked at 50 ppm for the 10 to 35 d period.
- G:F increased with increasing level of both Bioplex® and inorganic Zn.
  - Zn treatment did not affect ADFI.
  - Zn source did not significantly affect growth performance.
- Liver Zn:
  - Zn concentration increased with increasing dietary Zn level at 10 d.
  - Supplemental Zn increased total Zn content at 10 d.
  - Liver wt. (g & %BW) increased quadratically with dietary Zn level at 35 d.
  - Zn concentration and content increased linearly with dietary Zn at 35 d.
  - Zn content of heart and kidney increased with dietary Zn at 35 d.
  - Zn source did not affect tissue mineral composition.

Conclusion
- Conventional nursery diets need to be fortified with Zn.
  - An additional 75 ppm Zn is adequate to meet pig needs for growth.
  - Innate Zn + added Zn = 100 total ppm Zn needed to maximize ADG

Table 2. Postweaning pig growth response to supplemental Zn sources and concentrations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Con 0</th>
<th>Org 25</th>
<th>Org 50</th>
<th>Org 75</th>
<th>Org 100</th>
<th>Inorg 25</th>
<th>Inorg 50</th>
<th>Inorg 75</th>
<th>Inorg 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW, kg</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
<td>6.3</td>
</tr>
<tr>
<td>10 d</td>
<td>7.2</td>
<td>7.4</td>
<td>7.2</td>
<td>7.7</td>
<td>7.3</td>
<td>7.4</td>
<td>7.4</td>
<td>7.4</td>
<td>7.6</td>
</tr>
<tr>
<td>35 d</td>
<td>16.9</td>
<td>19.3</td>
<td>19.6</td>
<td>19.8</td>
<td>19.5</td>
<td>19.8</td>
<td>19.7</td>
<td>19.2</td>
<td>19.5</td>
</tr>
</tbody>
</table>

Table 3. Postweaning pig feed efficiency response to supplemental Zn sources and concentrations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Con 0</th>
<th>Org 25</th>
<th>Org 50</th>
<th>Org 75</th>
<th>Org 100</th>
<th>Inorg 25</th>
<th>Inorg 50</th>
<th>Inorg 75</th>
<th>Inorg 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADFI, g/d</td>
<td>200</td>
<td>195</td>
<td>187</td>
<td>222</td>
<td>192</td>
<td>184</td>
<td>197</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>10 d</td>
<td>719</td>
<td>735</td>
<td>755</td>
<td>777</td>
<td>734</td>
<td>791</td>
<td>722</td>
<td>747</td>
<td>766</td>
</tr>
<tr>
<td>35 d</td>
<td>534</td>
<td>542</td>
<td>552</td>
<td>576</td>
<td>540</td>
<td>574</td>
<td>537</td>
<td>552</td>
<td>563</td>
</tr>
</tbody>
</table>

Table 4. Effect of supplemental Zn concentration on Zn content of liver.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>10 d</th>
<th>35 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, g</td>
<td>129</td>
<td>651</td>
</tr>
<tr>
<td>% BW</td>
<td>1.78</td>
<td>3.43</td>
</tr>
<tr>
<td>Zn, ppm</td>
<td>46</td>
<td>3.46</td>
</tr>
<tr>
<td>Total Zn, g</td>
<td>5.9</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Table 5. Effect of supplemental Zn concentration on Zn content of heart and kidneys at 35 d.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>10 d</th>
<th>35 d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, g</td>
<td>98</td>
<td>62</td>
</tr>
<tr>
<td>% BW</td>
<td>0.52</td>
<td>0.33</td>
</tr>
<tr>
<td>Zn, ppm</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>Total Zn, g</td>
<td>1.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*Linear relationship with supplemental Inorganic Zn concentration, P<0.05
*Quadratic relationship with supplemental Bioplex Zn concentration, P<0.05
*Control vs supplemented trts P=0.05
*Linear relationship with supplemental Bioplex Zn concentration, P<0.05
*Quadratic relationship with supplemental Bioplex Zn concentration, P<0.05

Switching from Sel-Plex® and Bioplex® mineral supplements to inorganic minerals in the grower-finisher phase was detrimental to pig performance

D.B. Monis¹ and A.J.L. Frio²
¹Tiaoeng Lucky Farm, Quezon, Philippines, ²Alltech Biotechnology Corp., Philippines

Objective
To determine the effect of feeding inorganic minerals to grower-finisher pigs that had consumed only organic minerals since birth.

Experimental design
• 108 Large White-Landrace x Pietrain-Duroc, mixed-sex (50:50) pigs
• Two treatment groups with 3 pens/trt, 18 pigs/pen
• Naturally ventilated barns, 1 m³/pig, 2 nipple drinkers/pen
• Feeding ad libitum, automatic feeders, 3 pigs per feeder hole
• Feeding program specs
  – Grower feed from 40-70 kg BW, finisher feed 70 kg up
  – Grower: 3,100 kcal ME, 1% total lysine, 0.85% Ca, 0.40% available P
  – Finisher: 3,000 kcal ME, 1% total lysine, 0.8% Ca, 0.35% available P
• Treatments (see Table 1)
• Trial duration: 40 to 100 kg (84 to 142 d of age)

Results
• Pigs that continued to be fed Sel-Plex® and Bioplexes® in the grower-finisher phase were on average 3 kg heavier compared with pigs that were switched to inorganic mineral supplements (Table 2).
• Likewise, the average daily gain of pigs that continued to be fed Sel-Plex® and Bioplexes® in the grower-finisher phase was 10 g/d more, feed intake was 157 g/d more, and FCR was 13 point lower compared with pigs that were switched to inorganic mineral supplements.

Conclusion
In pigs that had been fed Bioplexes® and Sel-Plex® (Alltech Inc.) since birth, replacement of organic minerals with inorganic mineral supplements in the growing-finishing stage resulted in reduced performance compared with continued feeding with the organic minerals.

Table 1. Mineral composition of treatments.
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Inorganic premix*</th>
<th>Bioplex® + Sel-Plex®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn, ppm</td>
<td>75</td>
<td>60</td>
</tr>
<tr>
<td>Cu, ppm</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Fe, ppm</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>Mn, ppm</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Se, ppm</td>
<td>0.15</td>
<td>0.3</td>
</tr>
<tr>
<td>I, ppm</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Cr, ppm</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>
* Inorganic premix group was fed Bioplexes® + Sel-Plex® since birth with no inorganic minerals.

Table 2. Effect of organic minerals on pig performance.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Inorganic premix</th>
<th>Bioplex® + Sel-Plex®</th>
<th>SEM</th>
<th>P</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight, kg</td>
<td>41.22</td>
<td>41.10</td>
<td>0.49</td>
<td>0.911</td>
<td>+ 3</td>
</tr>
<tr>
<td>Final weight, kg</td>
<td>93.81</td>
<td>96.93</td>
<td>1.01</td>
<td>0.127</td>
<td>+ 3</td>
</tr>
<tr>
<td>ADG, kg/d</td>
<td>0.852</td>
<td>0.948</td>
<td>0.02</td>
<td>0.0048</td>
<td>+ 10</td>
</tr>
<tr>
<td>ADFI, kg/d</td>
<td>2.49</td>
<td>2.65</td>
<td>0.06</td>
<td>0.0348</td>
<td>+ 157</td>
</tr>
<tr>
<td>FCR</td>
<td>2.93</td>
<td>2.80</td>
<td>0.04</td>
<td>0.481</td>
<td>- 13</td>
</tr>
</tbody>
</table>
Use of NuPro® in pre-lactation and lactation sows: Effects on reproductive parameters and litter performance

1Pupa, J.M.R., Hanaus, M.J. 2Allnutri Ltda., Viçosa, Minas Gerais, Brazil, 2Alltech Brazil

Introduction

NuPro® (Alltech Inc.) is a source of protein, amino acids, nucleotides and other essential nutrients for swine. Several studies demonstrate that NuPro® improves weight gain, feed consumption and immunological parameters of piglets. However, scientific results in sows are still limited.

Objective

To evaluate the effects of NuPro® on the reproductive performance of sows and the subsequent development of their litters.

Methods

• 68 sows
• Completely randomized experimental design
• 2 treatments (T1 & T2), with 35 & 33 replicates, respectively
• Treatments: T1 – Control; T2 – Control + 2.0% NuPro®
• Isonutritive diets formulated as per Rostagno et al. (2005)
• Controlled feeding: 3.0 kg of feed/d fed to sows from 95 to 110 d of age
• 5 d before farrowing, sows were individually penned and fed lactation feed (3.0 kg/d) until 12 h before farrowing.
• After farrowing, sows were fed lactation feed divided into 2, 3 or 4 meals, until weaning (Table 1).
• Measurements included number of piglets born alive, stillbirths, mummified, return-to-estrus rate, body score of sows at weaning. Piglets were weighed at birth, 7 d of age, and at weaning. Occurrence of diarrhea, mortality rate and culling were recorded.
• Data were analyzed using ANOVA. Performance means were compared by F test; means for mortality and incidence of diarrhea were compared by non-parametric test (P<0.05).

Results

• No effects of treatments were observed on the reproductive parameters (P>0.05).
• At weaning, the sows from both treatments showed body score of 2.0. However, the weaning-estrus intervals were 7.7 d (Control) and 7.0 d (NuPro®).
• Pre-weaning mortality rate and number of non-viable animals were lower in piglets born from sows fed NuPro® during the pre-lactation and lactation phases (Table 2).
• NuPro fed to sows improved (P<0.05) piglet weight at birth, at 7 d of age and at weaning: (+9.7, 11.75 and 12.34%, respectively). Likewise, average daily gain in piglets born from sows fed NuPro® was 15 and 13% higher in the first week of life and from birth to 20 d of age, respectively (Table 2).

Conclusions

• Inclusion of NuPro® at 2% in sow diets during pre-lactation and lactation phases promoted better performance of litter before weaning, including higher weight gain (+590 g/piglet), reduced mortality, and reduced culling (- 4.8 percentage points).
• NuPro® inclusion showed positive ROI (2.66:1).

Table 1 – Feeding of lactation diets according to the days of lactation

<table>
<thead>
<tr>
<th>Days of lactation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kg of feed/day</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2 – Relative number and percentage of mortality and culling causes

<table>
<thead>
<tr>
<th>Causes</th>
<th>1st week</th>
<th>After 1st week</th>
<th>Causes</th>
<th>1st week</th>
<th>After 1st week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-viable</td>
<td>19 (5.4%)</td>
<td>5 (1.5%)</td>
<td>Non-viable</td>
<td>5 (1.5%)</td>
<td></td>
</tr>
<tr>
<td>Crushed</td>
<td>13 (3.7%)</td>
<td>8 (2.4%)</td>
<td>Crushed</td>
<td>8 (2.4%)</td>
<td>13 (3.8%)</td>
</tr>
<tr>
<td>Total - 39 (11%)</td>
<td>34 (9.7%)</td>
<td>5 (1.4%)</td>
<td>Total - 21 (6.2%)</td>
<td>8 (2.4%)</td>
<td>13 (3.8%)</td>
</tr>
</tbody>
</table>

Table 3 – Effect of NuPro® during the pre-lactation and lactation phases on live weight (LW), weight gain (WG) and average daily gain (ADG) of piglets.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day 1</th>
<th>Day 7</th>
<th>Day 20</th>
<th>Days 1–7</th>
<th>Days 1–2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1453a</td>
<td>2432a</td>
<td>4708a</td>
<td>978b</td>
<td>3327b</td>
</tr>
<tr>
<td>Control + NuPro®</td>
<td>1595a</td>
<td>2718a</td>
<td>5370a</td>
<td>1123a</td>
<td>3774a</td>
</tr>
<tr>
<td>CV</td>
<td>21.86</td>
<td>20.94</td>
<td>23.59</td>
<td>36.51</td>
<td>36.51</td>
</tr>
</tbody>
</table>

a,bMeans differ (P<0.05)

Introduction

NuPro® (Alltech Inc.) is a source of protein, amino acids, nucleotides and other essential nutrients for swine. Several studies demonstrate that NuPro® improves weight gain, feed consumption and immunological parameters of piglets. However, scientific results in sows are still limited.

Objective

To evaluate the effects of NuPro® on the reproductive performance of sows and the subsequent development of their litters.
Microarray analysis of genes regulated by both Bioplex® Cu and CuSO₄ in the jejunum of weanling pigs

Blaire Aldridge¹, Rijin Xiao², Darrell Mallonee², Ronan Power³, Karl Dawson⁴, and Scott Radcliffe¹
¹Purdue University Animal Sciences Department, West Lafayette, IN, ²Center for Animal Nutrigenomics and Applied Animal Nutrition, Alltech, Nicholasville, KY

Introduction
Copper (Cu) is required by all living organisms for growth and development and its unique characteristics (ox/redox) provide for essential cofactors, helping physiologic functions such as connective tissue formation, iron metabolism, melanin pigment formation, cardiac function, cholesterol metabolism and immune function. Though suitable for catalytic activity, the redox activity of Cu renders it toxic when it accumulates at high levels through the production of reactive oxygen species, and therefore can alter cellular stress and activities. Little work has been done to examine how dietary Cu affects gene transcription in the enterocyte (intestinal absorptive cell) of the pig.

Objective
To determine the effect of Bioplex® Cu (Alltech Inc.) or CuSO₄ in the jejunum of weanling pigs, and CuSO₄ in the jejunum of weanling pigs

Materials and methods
• 30 crossbred barrows weaned at 201±1 d
• 3 treatment groups (n=10): Cu supplementation for 14 d at 37 ppm (Bioplex®), or 25 ppm CuSO₄
• Prior to receiving test diets all pigs were given 3 d of control diet
• RNA was isolated from mucosal scrapings and components of enterocyte (intestinal absorptive cell) of the pig.

Results
• Of the 71 commonly expressed transcripts, 29 were up-regulated (Table 1) and 29 were down-regulated (Table 3) (P<0.05, FC>1.2).

Conclusion
These data show novel, commonly regulated pathways between CuSO₄ and Bioplex® Cu, point to Cu-specific genes, and transcriptionally verify Cu-related functions involved in apoptosis, cell signaling and cellular immune responses in swine.

Table 1. Top networks and biofunctions common to CuSO₄ and Bioplex® Cu in the proximal jejunum of weanling pigs.

<table>
<thead>
<tr>
<th>Associated network functions</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematological System Development and Function, Immune Cell Trafficking, Inflammatory Response</td>
<td>47</td>
</tr>
<tr>
<td>Cellular Assembly and Organization, Cellular Movement, Skeletal and Muscular Disorders</td>
<td>28</td>
</tr>
<tr>
<td>Cancer, Infectious Disease, Inflammatory Disease</td>
<td>26</td>
</tr>
<tr>
<td>Neurological Disease, Cardiovascular System Development and Function, Organizational Development</td>
<td>20</td>
</tr>
<tr>
<td>Cell Death, Cardiac Neuron/Cell Death, Cellular Growth and Proliferation</td>
<td>14</td>
</tr>
</tbody>
</table>

Table 2. Top networks and biofunctions up-regulated by both Bioplex® Cu and CuSO₄ in the proximal jejunum of weanling pigs.

<table>
<thead>
<tr>
<th>Associated up regulated network functions</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell Morphology, Cellular Assembly and Organization, Cardiac Proliferation</td>
<td>32</td>
</tr>
<tr>
<td>Drug Metabolism, Endocrine System Development and Function, Lipid Metabolism</td>
<td>31</td>
</tr>
<tr>
<td>Cellular Assembly and Organization, Hair and Skin Development and Function, Organ Morphology</td>
<td>27</td>
</tr>
<tr>
<td>Lipid Metabolism, Molecular Transport, Small Molecule Biochemistry</td>
<td>24</td>
</tr>
<tr>
<td>Carbohydrate Metabolism, Lipid Metabolism, Small Molecule Biochemistry</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 3. Top networks and biofunctions down-regulated by both Bioplex® Cu and CuSO₄ in the proximal jejunum of weanling pigs.

<table>
<thead>
<tr>
<th>Associated down regulated network functions</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gene Expression, Organ Development, Cell-To-Cell Signaling and Interaction</td>
<td>45</td>
</tr>
<tr>
<td>Nervous System Development and Function, Cell Morphology, Cellular Development</td>
<td>34</td>
</tr>
<tr>
<td>Gene Expression, Cell Morphology, Cellular Assembly and Organization, Lipid Metabolism</td>
<td>25</td>
</tr>
<tr>
<td>Tumor Morphology, Amino Acid Metabolism, Post-Translational Modification</td>
<td>25</td>
</tr>
<tr>
<td>Lipid Metabolism, Molecular Transport, Small Molecule Biochemistry</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 1. Top networks and biofunctions common to CuSO₄ and Bioplex® Cu in the proximal jejunum of weanling pigs.

<table>
<thead>
<tr>
<th>Top Biological Functions</th>
<th>No. altered Genes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular and Cellular Functions</td>
<td>15</td>
</tr>
<tr>
<td>Cell Cycle</td>
<td>7</td>
</tr>
<tr>
<td>Cell Death</td>
<td>7</td>
</tr>
<tr>
<td>Cellular Compromise</td>
<td>6</td>
</tr>
<tr>
<td>Energy Production</td>
<td>5</td>
</tr>
<tr>
<td>Nucleic Acid Metabolism</td>
<td>5</td>
</tr>
<tr>
<td>Diseases and Disorders</td>
<td>5</td>
</tr>
<tr>
<td>Cancer</td>
<td>30</td>
</tr>
<tr>
<td>Gastrointestinal Disease</td>
<td>14</td>
</tr>
<tr>
<td>Inflammatory Response</td>
<td>6</td>
</tr>
<tr>
<td>Neurological Disease and Conditions</td>
<td>8</td>
</tr>
<tr>
<td>Developmental Disorder</td>
<td>10</td>
</tr>
<tr>
<td>Physiological System Development and Function</td>
<td>20</td>
</tr>
<tr>
<td>Hematological System Development and Function</td>
<td>16</td>
</tr>
<tr>
<td>Immune Cell Trafficking</td>
<td>14</td>
</tr>
<tr>
<td>Tissue Development</td>
<td>9</td>
</tr>
<tr>
<td>Cardiovascular System Development and Function</td>
<td>7</td>
</tr>
<tr>
<td>Connective Tissue Development and Function</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 1. Venn diagram of transcripts commonly expressed in the proximal jejunum of weanling pigs when fed 25 ppm Cu from either CuSO₄ or Bioplex® Cu. Of the 71 commonly expressed genes, 42 were down-regulated and 29 up-regulated.
Ionomic profile changes in the intestine, liver, kidney, serum and gall bladder contents due to copper source and concentration

Blaire Aldridge¹, Ronan Power², Karl Dawson³ and Scott Radcliffe¹
¹Purdue University, Animal Sciences Department, West Lafayette, IN, ²Center for Animal Nutrigenomics and Applied Animal Nutrition, Alltech Inc., Nicholasville, KY

Introduction
The term ionomics refers to the mineral nutrient and trace element composition of a biologic system. From the ionomic profile of organs in the pig, we can understand how changes of one dietary mineral concentration and form can alter the status of other minerals. Antagonist or protagonist mineral relationships can occur for a variety of reasons including precipitation, competition for shared transport, similar chemical structure, and shared transcription factors that can up or down regulate gene transcription. Although we know certain mineral-mineral interactions exist, it is not clear which dietary concentrations and forms of Cu interact and alter the status of other minerals in select organs.

Objective
To compare the effects of CuSO₄ and Bioplex® Cu (Alltech Inc.) on the ionomic profiles (intestinal, liver, gall bladder contents, kidney, and serum) of weanling pigs.

Materials and methods
• 70 crossbred barrows, weaned at 20±1 d of age
• 2x3 factorial design: Cu source (CuSO₄ and Bioplex® Cu) at 0, 4, 25, or 125 ppm in complex diet
• 7 treatments:10 pigs/treatment
• Diet (Table 1); treatments (Table 2)
• Sampling and analysis:
  – Pigs were euthanized via asphyxiation with CO₂, 4 h after the 1st morning feeding.
  – Immediately after death, proximal jejunum (115 cm distal to pyloric sphincter), kidney, liver and gall bladder samples were collected and stored at -20°C.
  – Before euthanasia, blood serum was isolated and stored at -80°C till analysis.
• Mineral concentrations were analyzed by ICP-MS.
• Data were analyzed in SAS:
  – MIXED Procedure to analyze 2x3 factorial design
  – GLM Procedure to run linear or quadratic contrasts on mineral concentrations.

Results
• Figure 1 shows changes in organ Cu concentrations in response to changes in dietary CuSO₄ or Bioplex® Cu.

Antagonist mineral-mineral relationships
• As dietary Cu increased, intestinal molybdenum (Mo) and magnesium (Mg) (Figure 2) concentrations decreased linearly.
• Intestinal and kidney Zn concentrations (Figure 3) decreased significantly only when Cu was fed at 25 ppm.
• The addition of 125 ppm dietary Cu decreased the concentrations of Mo and selenium (Se) (Figure 4) in gall bladder contents.

Protagonist mineral-mineral relationships
• Zinc concentration in gall bladder contents increased only with the lowest level of dietary Cu (4 ppm) (Figure 5).
• Liver concentrations of manganese (Mn) and Se (Figure 6) increased linearly as dietary Cu increased.
• Feeding 125 ppm Cu significantly increased concentrations of cobalt (Co) and Mn in the kidney Co in serum (Figure 7) and iron (Fe) in the intestine.

Heavy metal accumulation
• Feeding increasing levels of Cu linearly increased liver lead (Pb) (Figure 8) and Cd—more of each accumulating from CuSO₄ compared with Bioplex® Cu.
• Level of Cd accumulation in the kidney was highest at 125 ppm Cu; the increase was 16% greater for pigs fed CuSO₄ (Figure 9).

Serum selenium and Mo
• Overall, when pigs were fed Cu from Bioplex® Cu, more serum Se (Figure 10) and Mo was present in blood serum.

Implications
• Mineral-mineral antagonist and protagonist relationships should not be generalized, but rather defined based on mineral concentrations/forms and target organs.
• Dietary Cu affects the metabolism of a variety of minerals, which is an important consideration in establishing dietary requirements.
• These data show that heavy metal accumulation occurs when Cu is fed at higher levels; this accumulation is less pronounced for Bioplex® Cu than for CuSO₄.
Use of Actigen™ – Performance, E. coli control and antimicrobial revitalization

_**Dra. Gertrudes Corção¹, Alessandra Alves de Paulo², Melissa Isabel Hannas², Anderson A. da Veiga²;¹ UFRGS, Altech do Brazil²**_

**Proposal**

The aim of the study was to control secondary bacterial growth in swine during growing and finisher phases, through the synergistic effect among the use of antibiotic and Actigen™, minimizing the effects of the secondary diseases which can be increased by Circovirosis and/or other sanitary challenges.

**Parameters Evaluated**

- Initial weight
- Average age
- Final weight
- Average age in the end of the trial
- Weight gain in the total period
- Feed intake
- Feed efficiency (FCR)
- EPEF
- Evaluation of antibiotic program
- E. coli investigation: Antibiogram for pathogenic E. coli
- Drug program costs

**Treatments**

Three groups were used in the evaluation:
1. Control: finishing pigs (3 months before starting use of Actigen™)
2. Actigen™ partial – finishing pigs (3 months after starting Actigen™)
3. Actigen™ – finishing pigs (4 to 7 months after starting Actigen™)

**Conclusions**

1. In 7 months Actigen™ was associated with higher sensitivity of E. coli to antibiotics with no changes in the management program
2. ROI per animal with Actigen™ was 6:1
3. Net profits = + $4,086.00
4. Antibiotic revitalization for E. coli
5. Better ADG and EFPF

**Graphic 1:** E. coli sensitivity to enrofloxacin in response to dietary Actigen™

**Graphic 2:** E. coli sensitivity to ceftiofur in response to dietary Actigen™

**Graphic 3:** E. coli sensitivity to spectinomycin in response to dietary Actigen™

**Graphic 4:** E. coli sensitivity to collistin sulfate in response to dietary Actigen™

**TABLE 1: TOTAL ANTIMICROBIAL ANALYSIS WITHOUT AND WITH ACTIGEN**

<table>
<thead>
<tr>
<th></th>
<th>BEFORE</th>
<th>AFTER</th>
<th>BEFORE</th>
<th>AFTER</th>
<th>BEFORE</th>
<th>AFTER</th>
<th>BEFORE</th>
<th>AFTER</th>
<th>BEFORE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLISTIN SULPHATE</td>
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<td>18</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TETRACYCLIN</td>
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<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOXACYCLIN</td>
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<td>5</td>
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<td>0</td>
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<td></td>
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<td></td>
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<tr>
<td>FORPHENICOL</td>
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<td>80</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ENRIOFLAXIN</td>
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<td>18</td>
<td>13</td>
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<td>0</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>CETIPOUR</td>
<td>78</td>
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<td>15</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>SPECTINOMYCIN</td>
<td>78</td>
<td>1</td>
<td>18</td>
<td>3</td>
<td>5</td>
<td>95</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Source: UFRGS. Not published

**TABLE 2 - PERIOD EVALUATED PERFORMANCE RESULTS FOR ALL THE PRODUCTION UNITS**

<table>
<thead>
<tr>
<th></th>
<th>AVERAGE RESULTS OF THE UNITS</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CONTROL</td>
<td>ACTIGEN</td>
</tr>
<tr>
<td>MORTALITY</td>
<td>2.35</td>
<td>2.47</td>
</tr>
<tr>
<td>ADJUSTED FCR</td>
<td>2.552</td>
<td>2.569</td>
</tr>
<tr>
<td>EFPF</td>
<td>291.33</td>
<td>307.50</td>
</tr>
<tr>
<td>FEED INTAKE, kg</td>
<td>255.15</td>
<td>256.91</td>
</tr>
</tbody>
</table>
Bioplex® and inorganic Zn effects on antioxidant enzymes and metallothionein in nursery pigs

G. M. Hill, J. E. Link, and D. C. Mahan,
Michigan State University; The Ohio State University

Introduction
Swine diets are often supplemented with minerals in excess of requirements despite the fact that excess minerals in manure can pose a threat to environmental sustainability. Zinc (Zn) is critical for nursery pig performance (growth) and health (immune function, antioxidant activity).

Objective
To determine the need for Zn in nursery pigs in response to inorganic, organic, or combined Zn supplements.

Methods
- Pigs weaned at 17 – 19 d of age allotted to pens based on weight, sex, and litter.
- 2-phase complex nursery diet (NRC 1998, except Zn): Phase 1 (0 – 10 d), Phase 2 (11 – 35 d)
- 10 dietary treatments: Basal diet (no added Zn); Basal diet + Zn at 25, 50, 75, or 100 ppm as either Bioplex® Zn (Alltech Inc.) or as ZnSO4; Basal diet + 25 ppm Zn (Bioplex®) + 25 ppm Zn as ZnSO4
- Liver and intestinal mucosa were sampled at weaning (6 pigs/trt), 10 d post-weaning (12 pigs/trt), and 35 d post-weaning (16 pigs/trt).
- Liver analyses included Mn superoxide dismutase (Mn SOD), Cu/Zn superoxide dismutase (Cu/Zn SOD), Glutathione peroxidase (GSH-Px), Metallothionein protein (MT).
- Intestinal mucosa analyses included duodenum MT and jejunum MT.

Results
- MnSOD activity was greater at 10 d than at 35 d post-weaning (Table 1).
- GSH-Px activity was lower at 10 d than at 35 d post-weaning (Table 2).
- MT concentration was greater in duodenum than in the jejunum (Figures 1 and 2).
- Duodenal MT was generally greater using Bioplex® Zn (Figures 1 and 2).
- Hepatic MT concentration was greater using Bioplex® Zn than ZnSO4 at 25 and 50 ppm (Figure 3).
- Hepatic Cu/ZnSOD activity was greater using the basal diet compared with supplemented diets (Figure 4).
- Hepatic Cu/ZnSOD activity was lower using the combination trt compared with the single-source trts (Figure 4).

Conclusions
- Organic Zn from Bioplex® may be more effective in providing Zn for biologic functions compared with Zn sulfate.
- A minimum of 75 ppm Zn should be added to a complex nursery diet in pigs.

Table 1. Hepatic MnSOD in response to Zn dietary supplementation in nursery pigs.

<table>
<thead>
<tr>
<th>Days post-weaning</th>
<th>0 ppm</th>
<th>25 ppm</th>
<th>50 ppm</th>
<th>75 ppm</th>
<th>100 ppm</th>
<th>50 ppm Bioplex® + ZnSO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>3.88</td>
<td>4.75</td>
<td>4.72</td>
<td>4.32</td>
<td>4.39</td>
<td>4.30</td>
</tr>
<tr>
<td>P-value</td>
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<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Table 2. Hepatic GSH-Px in response to Zn dietary supplementation in nursery pigs.

<table>
<thead>
<tr>
<th>Days post-weaning</th>
<th>0 ppm</th>
<th>25 ppm</th>
<th>50 ppm</th>
<th>75 ppm</th>
<th>100 ppm</th>
<th>50 ppm Bioplex® + ZnSO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>10</td>
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<td>12</td>
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<tr>
<td></td>
<td>1.08</td>
<td>1.28</td>
<td>1.39</td>
<td>1.04</td>
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<tr>
<td>P-value</td>
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<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
Use of Actigen™ – Performance, Salmonella control and antimicrobial revitalization

DRA. GERTRUDES CORÇÃO¹, ALESSANDRA ALVES DE PAULO², MELISSA ISABEL HANNAS², ANDERSON A. DA VEIGA²
¹UFRGS, ALTÉCH BRAZIL²

Proposal

The aim of the study was to control secondary bacterial growth in swine during growing and finisher phase, through the synergistic effect with the use of an antibiotic and Actigen™, minimizing the effects of the secondary diseases which can be increased by Circovirosis and/or other sanitary challenges.

Parameters Evaluated
- Initial weight
- Average age
- Final weight
- Average age in the end of the trial
- Weight gain in the total period
- Feed intake
- Feed conversion rate (FCR)
- Mortality
- EFPF (European Feed Production Factor)
- Evaluation of antibiotic program
- Salmonella investigation
- Antibiogram for Salmonella
- Drug program costs
- 3,040 piglets in the trial in 6 pig farms

Treatments

Three groups were used in the evaluation:
1- Control: finishing pigs (3 months before starting the use of Actigen™)
2- Actigen™ partial – finishing pigs (3 months after starting the use of Actigen™)
3- Actigen™ – finishing pigs (4 to 7 months after starting the use of Actigen™)

Conclusions

• 26 strains of Salmonella were isolated in the beginning of the trial and only one was isolated at the end of the trial.
• Actigen™ could reverse the antibiotic resistance with no changes in management in a period of only seven months.
• ROI per animal with Actigen™ was 6:1
• Net profits = + $4,086.00
• Antibiotic revitalization for Salmonella
• Better daily gain and EFPF

Table 1: Total Antibiogram Analysis Without and With Actigen™

<table>
<thead>
<tr>
<th>ANTIBIOTIC</th>
<th>BEFORE RESISTANT</th>
<th>AFTER RESISTANT</th>
<th>BEFORE INTERMEDIATE</th>
<th>AFTER INTERMEDIATE</th>
<th>BEFORE SENSITIVE</th>
<th>AFTER SENSITIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>COLISTIN SULPHATE</td>
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<td>0</td>
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<td>0</td>
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<td>TETRACYCLIN</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
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<td>DOXYCYCLIN</td>
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<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>100</td>
</tr>
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<td>0</td>
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<td>SPECTINOMYCIN</td>
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<td>0</td>
<td>0</td>
<td>9</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: UFRGS. Not published

Table 2 - Period Evaluated Performance Results for All the Production Units (UPLS from Cooperative and Pig Farmers)

<table>
<thead>
<tr>
<th>AVERAGE RESULTS OF THE UNITS</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
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<td>CONTROL</td>
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<tr>
<td>ADG, g/day</td>
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<tr>
<td>MORTALITY</td>
<td>2.35</td>
</tr>
<tr>
<td>FCR</td>
<td>2.70</td>
</tr>
<tr>
<td>ADJUSTED FCR</td>
<td>2.552</td>
</tr>
<tr>
<td>EFPF</td>
<td>291.33</td>
</tr>
<tr>
<td>FEED INTAKE, kg</td>
<td>255.15</td>
</tr>
<tr>
<td>ACTIGEN</td>
<td></td>
</tr>
</tbody>
</table>

Source: UFRGS. Not published