KeyShure Tool Kit

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KeyShure® Precision Release Minerals

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www.balchem.com
KeyShure®
Precision Release Minerals

MINERALS MADE RIGHT - QUALITY AND VALUE
Trace minerals are essential nutrients required by all animals to maintain health and maximize productivity. Even moderate deficiencies can adversely impact performance. Typically nutrient deficiencies are thought to be caused by under-feeding. However, trace mineral deficiencies are often seen in diets that appear, on paper, to contain adequate amounts of the mineral. This is because trace minerals are very reactive and interact with other compounds in the feed and digestive tract to create new molecules that are no longer bioavailable to the animal. Chelated trace minerals were invented to block these damaging reactions, allowing the trace minerals to be absorbed and utilized by the animal.

Chelated trace minerals are essential trace minerals that have been attached to a carbon–hydrogen based molecule which acts as a ligand. Ligands most frequently used include amino acids, peptides and proteins.

Scientific data, from across livestock species and production systems, demonstrate that chelated minerals improve animal performance, reduce reactivity with vitamins and reduce mineral excretion into the environment.
KeyShure®
Precision Release Minerals

KeyShure® Precision Release Minerals offer the winning combination of quality and value. You get the exceptional quality you expect from a world-class manufacturer and the no-frills, value-based pricing you need to maximize profitability.

- **High bioavailability** - Chelation maximizes bioavailability, establishing a protective chemical bond between a mineral and an appropriate organic compound. It is here, at the molecular level, that Balchem’s technology makes the difference.

- **Excellent quality** - Balchem uses scientific and manufacturing expertise to maximize the bioavailability of chelated minerals in our products. We keep it simple by focusing on the endpoint – binding minerals to high-quality, plant-protein-derived amino acids.

- **Exceptional value** - As a major ingredient supplier, Balchem leverages its purchasing power and efficient manufacturing processes to provide no-frills, value-based pricing for an extremely high-quality product.

KeyShure® Precision Release Minerals are the industry standard for combining excellent quality and reasonable prices to provide the best value per unit of bioavailable mineral.
Over the last 40 years, numerous research trials have proven the importance of bioavailable mineral supplementation for both ruminant and monogastric animals. High-quality, chelated minerals deliver the consistent bioavailability the animal needs to maximize performance.

However, not all chelated minerals perform the same. Two studies, conducted at the University of Florida, demonstrate the repeatable and consistent superiority of KeyShure® Precision Release Minerals relative to trace mineral bioavailability, in both monogastric and ruminant animals. Eight commercial chelated zinc products were compared to zinc sulfate, the standard inorganic form of zinc used in feeds. Only one product was statistically superior in trace mineral bioavailability to the control. KeyShure Zinc demonstrated 130% bioavailability in ruminants and 119% bioavailability in monogastrics compared to zinc sulfate. The study was repeated two years later and again, KeyShure Zinc demonstrated superior bioavailability.

KeyShure® Precision Release Minerals are:
- More bioavailable than inorganic trace minerals.
- More bioavailable than other chelated trace minerals.
- Proven, superior performance in both monogastric and ruminant animals.
Mineral bioavailability leads to consistent and predictable performance in the animal. One key aspect of demonstrating the high bioavailability of a chelated trace mineral source is its ability to improve animal performance in the presence of a trace mineral antagonist.

In a study conducted at the Virginia Diversified Research Corporation, the difference between zinc sources was very apparent in the presence of antagonists. KeyShure allowed broilers to achieve better growth (Figure 1), feed conversion (Figure 2), and lower mortality rates (not shown). KeyShure Zinc was the most bioavailable chelated trace mineral source because it was able to counteract the antagonists, allowing birds to achieve the greatest body weight at 42 days of age with the best feed efficiency. The other trace mineral sources were not as bioavailable.

The impact of a trace mineral antagonist on growth (42 day body weight and feed conversion) was significant:

- The antagonist depressed broiler growth by 14% and feed conversion rate by 16%.
- Supplemental zinc sulfate could not counteract the antagonist. Broiler weight was reduced by 13% on this diet.
- Feeding KeyShure Zinc overcame the effect of the antagonist and restored performance.
- Other commercially available chelated trace minerals only partially compensated for the antagonist’s effect on weight gain and feed efficiency.
Real Results. That’s what it all comes down to. Results you can count on, results to help you meet your goals. Results are more than numbers on a spreadsheet – they’re about tangible outcomes. Real results are about healthier, more productive animals. They’re about a plentiful and wholesome food supply and they’re about the satisfaction that comes with a job well done.

KeyShure® Precision Release Minerals were designed with your results in mind.

1. PERFORMANCE RESULTS

Feeding KeyShure® Precision Release Minerals in the diet can minimize the impact of antagonistic compounds in feed, water and the digestive tract, making trace minerals more available to the animal, which can improve health and productivity.

2. PROFITABILITY RESULTS

With a no-frills, value-based approach to producing and supplying chelated trace minerals, you can be assured that you only pay for what you need – high-quality, bioavailable minerals that will enhance animal performance. Increased savings and improved performance are a profitable combination.

3. ENVIRONMENTAL RESULTS

Feeding KeyShure® Precision Release Minerals can help improve mineral absorption in the small intestine, thus supporting optimum performance and decreasing mineral excretion into the environment.
To learn more about the complete portfolio of encapsulated nutrients and chelated minerals from Balchem, visit anh.balchem.com.

For more ways to improve transition management, visit www.transitioncow.net. You’ll find summaries of the newest research, blog posts from transition nutrition and management experts and tools to help get your transition cows off to a smoother, faster start.
KeyShure® Precision Release Minerals

**Application:**
Chelated trace minerals for cattle, swine, poultry, aquaculture, and pet food.

**Feeding Recommendations:**
*Balchem recommends replacing approximately 50% of the supplemental inorganic trace minerals required to meet National Research Council (NRC) recommended levels with KeyShure Precision Release Minerals.*

It is very common for nutritionists to formulate diets with trace mineral levels in excess of the levels recommended by the NRC. This is often done to compensate for potential antagonists in feeds that can render trace minerals ineffective. However, feeding higher trace mineral levels can in itself negatively affect utilization. Higher trace mineral cost and increasing concern over trace mineral excretion into the environment make this strategy even less attractive. Feeding KeyShure Precision Release Minerals can help overcome the effects of antagonists, thus supporting optimum performance and decreasing mineral excretion into the environment.

**Storage:**
Store under dry conditions in unopened bags.

**Packaging:**
25 kg (55 lb.) poly-line bags

**Shelf life:**
Minimum five years, if kept dry in unopened bags.

---

**KeyShure® Precision Release Minerals**

<table>
<thead>
<tr>
<th></th>
<th>Zinc</th>
<th>Copper</th>
<th>Manganese</th>
<th>Cobalt</th>
<th>Iron</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Potassium</th>
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</thead>
<tbody>
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<td>KeyShure® Copper</td>
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<td>KeyShure® Manganese</td>
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<td>KeyPlex 842</td>
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<td>KeyShure® Dairy</td>
<td>5.15%</td>
<td>1.8%</td>
<td>2.86%</td>
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**SoluKey™ Water Soluble Precision Release Minerals**

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<th>Zinc</th>
<th>Copper</th>
<th>Manganese</th>
<th>Cobalt</th>
<th>Iron</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Potassium</th>
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<tr>
<td>SoluKey™ Zinc</td>
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<tr>
<td>SoluKey™ Copper</td>
<td>12%</td>
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<td>SoluKey™ Manganese</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SoluKey™ Iron</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>SoluKey™ Magnesium</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
</tbody>
</table>
Benefits:

**High bioavailability** - Chelation maximizes bioavailability, establishing a protective chemical bond between a mineral and an appropriate organic compound. It is here, at the molecular level, that Balchem’s technology makes the difference.

**Excellent quality** - Balchem uses scientific and manufacturing expertise to maximize the bioavailability of chelated mineral in our products. We keep it simple by focusing on the endpoint - binding minerals to high-quality, plant-protein-derived amino acids.

**Exceptional value** - As a major ingredient supplier, Balchem leverages its purchasing power and efficient manufacturing processes to provide no-frills, value-based pricing for an extremely high-quality product. The result is the lowest cost per unit of organically bound (chelated) mineral in the industry.

Balchem

For more than 40 years, Balchem has perfected the art of delivering nutrients to specific locations under many different environmental conditions. Today Balchem’s technologies protect more than 140 different products across human, animal and industrial applications. Protect your entire nutrient investment with Balchem.

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Research: Independent research studies confirm that KeyShure Precision Release Minerals:

- Are more bioavailable than inorganic trace minerals.
- Are more bioavailable than any other organic trace minerals.
- Provides superior performance in both monogastric and ruminant animals.

**Bioavailability of different sources of zinc (lambs)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Liver</th>
<th>Pancreas</th>
<th>Kidney</th>
<th>Liver MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZnSO₄</td>
<td>100</td>
<td>103</td>
<td>108</td>
<td>100</td>
</tr>
<tr>
<td>Zn AA Complex</td>
<td>100</td>
<td>113</td>
<td>113</td>
<td>100</td>
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<td>Zn Methionine</td>
<td></td>
<td>107</td>
<td>107</td>
<td>100</td>
</tr>
<tr>
<td>KeyShure Zinc</td>
<td></td>
<td>128</td>
<td>131</td>
<td>100</td>
</tr>
</tbody>
</table>

Journal of Animal Science 2000. 78: 2039-2054

A, B Bars with different letters had significantly different (P<.05) regression coefficients for determining RBV.

For more information, just snap the QR codes or enter the url below.

anh.balchem.com/anh/chelated-minerals
Balchem Research Summary

Chemical characteristics and relative bioavailability of supplemental organic Zinc sources for poultry and ruminants.

A summary of research conducted at the University of Florida and published as:
Background

Trace minerals are universally recognized nutrients in livestock and human diets for their essential roles in enzyme systems, tissue integrity and immune function. Over the last twenty-five years there has been growing interest, and some evidence, for the use of trace minerals bound to organic ligands due to their hypothesized superior bioavailability in comparison to the inorganic salts of trace minerals. The existing research literature presents inconsistent physiological and production results in animal trials comparing inorganic and organic forms of trace minerals. In addition, there are no standardized chemical methods for the evaluation of organic trace minerals as it relates to the strength or degree of chelation between the trace mineral and its ligand. Lastly, very few studies have correlated chemical characterization with in vivo physiological effects. This research bulletin summarizes the results from two papers in which commercially available Zinc (Zn) organic trace minerals were chemically characterized and then compared to inorganic Zn salts in animal trials.

Methods

Chemical Characterization (J Anim Sci, 2000)

Eight commercially available organic trace minerals and reagent grade Zinc sulfate (ZnSO₄) were evaluated by several methods to determine: trace mineral and nitrogen content, strength of chelation, solubility at physiological pH, and chelation integrity at physiological pH. The products tested were: two Zn methionine products, a Zn polysaccharide, a Zn lysine, a Zn amino acid (AA) chelate and three Zn proteinates.

Nitrogen and Mineral Content: Samples were dried, ashed, solubilized in HCl, and filtered through ashless filter paper. The Zn content was evaluated by flame atomic absorption spectrophotometry. Nitrogen content was evaluated on a Technicon AutoAnalyzer II.

Polarographic Analysis: Chelation strength was analyzed with a hanging mercury drop electrode to determine the half-wave potential (E½) of saturated solutions of each product. The more positive the E½, the more stable a chelate is.

Solubility at pH 2 and 5: Solubility of each product at concentrations ranging from 0.125 mg/mL up to 12.5 mg/mL were evaluated in buffers at pH 2 and pH 5.

Gel Filtration Chromatography: The soluble fractions from the solubility evaluation were applied to a size exclusion gel and eluted in 0.2 mL aliquots. These were tested for mineral and nitrogen content to determine the separation of free metal ion, amino acids and small peptides, and metal chelates or complexes.

Bioavailability Trials

Experiment 1 (J Anim Sci, 2000)

Four hundred and thirty two broiler chicks were assigned to six pen replicates for each of eight treatments. The basal diet was formulated to meet NRC requirements for Zn. Additional ZnSO₄ was added at 0, 200, 400 or 600 mg/kg of DM as one set of treatments or additional Zn was added at either 200 or 400 mg/kg DM from one of two organic trace mineral sources, either a Zn AA chelate or a Zn proteinate (KeyShure Zinc). At 1, 2 and 3 weeks of age, three chicks from each pen were selected and sacrificed. Femurs, intestinal mucosa, intestinal serosa, and liver were harvested for analysis of Zn content or metallothionein activity.

Experiment 2 (J Anim Sci, 2000)

Forty-two cross-bred lambs were assigned to seven treatment groups. The basal diet contained 58 mg/kg of Zn and was formulated to meet NRC requirements for growing lambs. The inorganic Zn treatments included 0, 700, 1400 or 2100 mg/kg of ZnSO₄. The organic Zn treatments consisted of 1400 mg/kg of either KeyShure Zinc, Zn AA chelate or Zn methionine. Diets were fed for 21 days, at which time the lambs were sacrificed and samples taken from liver, kidneys and pancreas for analysis of Zn content or metallothionein activity.

Experiment 3 (Anim Feed Sci Tech, 2002)

This experiment differed from Experiment 1 in that supplemented Zn was formulated to be much closer to NRC requirements rather than at pharmacological levels. A secondary objective was to evaluate treatments for a much shorter period of time (9 days) as compared to typical three or six week studies in broilers. Four hundred and thirty two broiler chicks were assigned to six pen replicates for each of eight treatments. The basal diet was formulated to meet or exceed NRC requirements for growing chicks, except for Zn, which was formulated for 24 mg/kg of Zn. The treatments included Zn supplemented at 0, 30, 60 or 90 mg/kg of DM as Zn acetate, or 30 or 60 mg/kg of DM as Zn methionine or Zn proteinate (the same as KeyShure Zinc in the Cao, 2000 paper). At days 3, 6 and 9 of the experiment, three chicks were selected from each pen and sacrificed. Tibias, intestinal mucosa and livers were harvested for analysis of Zn content or metallothionein activity.

Results

Chemical Characterization (J Anim Sci, 2000)

The results of chemical characterization and chelation effectiveness are presented in Table 1. The values in the ΔE½ column represent the voltage required to break the bond between the ligand and trace metal. The higher the value, the stronger the chemical bond. Similarly, the formation quotient, Qf, is a quantitative measure of chelation effectiveness. Categorically, Qf values <10 are representative of very weak chelation, values between 10 and 100 represent moderate chelation and over 100 should be considered as strongly chelated.
**Zn Source Solubility**

There was wide variation in the solubility of the Zn and nitrogen (N) fractions of the commercial products in deionized water as seen in Table 1. The Zn:N ratio for KeyShure Zinc was highly consistent in both soluble and insoluble fractions, indicating that it was the only product which remained chelated under the conditions of this evaluation.

**Table 1. Characterization of Chelation Effectiveness of Organic Zn Sources.**

<table>
<thead>
<tr>
<th>Zn Source</th>
<th>ΔE½</th>
<th>Qf</th>
<th>Zn Soluble*</th>
<th>Zn Insoluble</th>
<th>N Soluble</th>
<th>N Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn Methionine A</td>
<td>.008</td>
<td>1.9</td>
<td>60</td>
<td>5</td>
<td>14</td>
<td>6</td>
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<tr>
<td>Zn Methionine B</td>
<td>.005</td>
<td>1.5</td>
<td>164</td>
<td>3</td>
<td>31</td>
<td>3</td>
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<tr>
<td>Zn Polysaccharide</td>
<td>.017</td>
<td>3.8</td>
<td>348</td>
<td>33</td>
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<td>7</td>
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<tr>
<td>Zn Lysine</td>
<td>.019</td>
<td>4.4</td>
<td>127</td>
<td>43</td>
<td>66</td>
<td>4</td>
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<tr>
<td>Zn Amino Acid Chel.</td>
<td>.067</td>
<td>180</td>
<td>149</td>
<td>17</td>
<td>48</td>
<td>77</td>
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<tr>
<td><strong>KeyShure</strong> Zinc</td>
<td>.033</td>
<td>13</td>
<td>41</td>
<td>206</td>
<td>45</td>
<td>131</td>
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<tr>
<td>Zn Proteinate B</td>
<td>.058</td>
<td>91</td>
<td>200</td>
<td>26</td>
<td>11</td>
<td>31</td>
</tr>
<tr>
<td>Zn Proteinate C</td>
<td>.062</td>
<td>120</td>
<td>216</td>
<td>10</td>
<td>40</td>
<td>58</td>
</tr>
</tbody>
</table>

Key to Chelation Effectiveness (Qf):

| Low | Moderate | High |

*All solubility values are reported in mg

**Gel Filtration Chromatography**

This method was able to distinguish unique peaks between free Zn ions, amino acids, peptides, complexes and chelates. Applying filtrates of the Zn sources mixed into pH 2.0 and pH 5.0 buffers, to the chromatograph resulted in distinct peaks for free Zn ion, indicating that none of the material remained chelated under these pH conditions. Under conditions of neutral pH, only 2.2% up to 12.2% of the Zn remained bound to its ligand, with the chelates (Zn AA and all Zn proteinates) demonstrating the highest degree of bound Zn (10.2% to 12.2%). The proportion of Zn remaining bound was positively correlated (r=0.96) to the log_{10} of the chelation effectiveness (Qf value in Table 1).

**Experiment 1: Broiler Chick Study** (J Anim Sci, 2000)

In this study, only Zn sulfate (ZnSO₄), Zn AA chelate and KeyShure Zinc were used as dietary treatments. There were significant main effects of Zn source and supplementation level at each week of the study across all of the response variables of feed intake, daily growth, bone Zn, intestinal Zn, mucosal Zn, liver metallothionein and mucosal metallothionein. The results for the terminal week of the experiment (week 3) and the highest level of Zn supplementation (400 mg/kg of added Zn) are summarized in Figure 1. The estimated bioavailability, based on bone and mucosal Zn, was 104% for Zn AA chelate and 139% for KeyShure Zinc when compared to results with Zn sulfate (ZnSO₄).
**Experiment 2: Lamb Study** (J Anim Sci, 2000)

As expected, Zn levels increased in all tissues with increasing Zn intake. When regressing tissue levels on Zn intake, liver Zn had the poorest fit with an R² of 0.61. The linear fit for kidney and pancreas Zn and liver metallothionein were 0.73, 0.74 and 0.77, respectively. For these same measures, the slope of the line was greatest for KeyShure Zinc, indicating a higher level of bioavailability than for Zn sulfate (ZnSO₄). Based on all four parameters measured, the bioavailability relative to Zn sulfate (ZnSO₄) (100%) was 110% for Zn amino acid complex, 113% for Zn Methionine B and 130% for KeyShure Zinc (Figure 2).
**Experiment 3: Broiler Chick Study** (Anim Feed Sci Tech, 2002)

There were significant effects of age, Zn supplementation level and Zn source on the accumulation of Zn in bone and mucosal metallothionein. Only the Zn proteinate had a significant effect on feed intake (P<.05). The results are summarized in Table 2 for the terminal time point (9 days) and highest Zn supplementation level (60 mg/kg) used across all treatments.

Table 2.

<table>
<thead>
<tr>
<th>Zn Source</th>
<th>Daily Feed Intake (g)*</th>
<th>Body Weight (g)</th>
<th>Bone Zn (mg/kg)*</th>
<th>Liver MT (ug/g)*</th>
<th>Mucosal MT (ug/g)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn Acetate</td>
<td>19.2</td>
<td>148.7</td>
<td>456</td>
<td>10.5</td>
<td>34.0</td>
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<tr>
<td>Zn Methionine</td>
<td>19.3</td>
<td>153.6</td>
<td>436</td>
<td>11.6</td>
<td>33.5</td>
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<td><strong>KeyShure Zinc</strong></td>
<td><strong>20.3</strong></td>
<td><strong>163.0</strong></td>
<td><strong>476</strong></td>
<td><strong>14.4</strong></td>
<td><strong>37.0</strong></td>
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</table>

* Significant main effect of source, P<.05;  * Significant main effect of source, P<.001

The mucosal metallothionein response to dietary Zn level was the most consistent response variable for all of the time points with R² of 0.83, 0.80 and 0.81 for days 3, 6 and 9, respectively. Using the mucosal metallothionein response at day 9 to calculate bioavailability relative to Zn acetate (100%), Zn methionine was 77% and Zn Proteinate was 130%. In summary, shorter supplementation trials can be effective when Zn is supplemented in ranges closer to animal requirements. Mucosal metallothionein appears to be the most consistent response.

**Summary**

Across the chemical characterizations and animal trials, KeyShure Zinc demonstrated the most consistent chelation effectiveness and performance. KeyShure Zinc exhibited a moderate chelation strength, consistent solubility of metal and nitrogen components and the highest degree of binding at a neutral pH. In animal trials in broilers and lambs, KeyShure Zinc had the highest bioavailability, >130% relative to ZnSO₄, of any of the commercial products tested when assessed by growth performance, and Zn accumulation in bone, tissue or enzyme systems.
Balchem Research Summary

Deposition of and performance responses to Zn from three organic sources fed to broiler chickens in the presence of cottonseed hull diets containing gossypol.

A summary of a study conducted by M. D. Sims*1 and M. J. de Veth2,1, Virginia Diversified Research Corp., Harrisonburg, VA, 2Balchem Corp., New Hampton, NY.
Objective
To evaluate the response (weight gain, feed efficiency, mortality) of broilers to dietary supplementation with inorganic Zinc (Zn) as Zn sulfate (ZnSO₄) or three different organic Zn sources in the presence of two dietary antagonists (phytate and gossypol) from cottonseed hulls (CSH). Antagonists negatively impact Zn absorption in monogastrics. Organic Zn sources, if highly bioavailable, can overcome the effect of an antagonists on Zn absorption.

Treatments
- ZnSO₄ no antagonist (PCON) - 40 ppm Zn from ZnSO₄, no antagonist.
- Basal Zn with antagonist (NCON) - no added Zn, antagonist added.
- ZnSO₄ - 40 ppm Zn from ZnSO₄, antagonist added.
- KeyShure® Zinc - 40 ppm Zn from KeyShure Zinc, antagonist added.
- Availa-Zn - 40 ppm Zn from Availa-Zn, antagonist added.
- Mintrex Zn - 40 ppm Zn from Mintrex Zn, antagonist added.

Diets and Birds
Diets: Single-phase 20% Protein, ME = 1400 kcal/lb, 9.9% fat – corn/soy diet, naturally adequate for all minerals (except Mn and I which were added) and then supplemented with appropriate Zn source at 40 ppm.

Birds: Straight-run Cobb x Ross broilers (1 to 42d of age). Housing consisted of 48 – 4’ X 4’ floor pens with 25/birds/pen.

Measurements
- Body weights by pen at 28d and 42d of age (Figure 1)
- Feed Conversion Ratio (FCR) at 28d and 42d (Figure 2)
- Bone Zn (Femurs) at 28d and 42d (Table 1)
- Total Mortality (Table 2)

Results
Figure 1. 42d Body weights of treatments compared to PCON treatment. PCON value was set to 100% (ideal standard ration with no antagonist and adequate Zn).

Figure 2. Feed conversion rates (FCR) compared to PCON. PCON value was set to 100% (ideal standard ration with no antagonist and adequate Zn).

Commercial Implications
The difference between Zn sources is amplified in the presence of an antagonist. Organic trace minerals, because of their higher bioavailability than the inorganic trace mineral source, permitted the birds to achieve better growth and feed conversion. The KeyShure Zinc treatment was the most bioavailable organic trace mineral source because it was able to counteract the antagonist, allowing the birds to obtain the greatest body weight at 42d of age with improved FCR.
KeyShure Zinc Advantages

**Body weights:** KeyShure Zinc treatment had the largest 42d body weights (p < .05) vs. all other antagonist-containing treatments. KeyShure Zinc birds had 42d body weights comparable to PCON birds.

**42d Adjusted Feed Conversion Ratio (lb/lb):**
KeyShure Zinc and PCON (positive control) treatments had similar feed conversion ratios (1.690 and 1.661, respectively) and were both more efficient than the other treatments.

**Cost Analysis:** KeyShure Zinc birds had higher (p < .05) rate of net return/broiler marketed over feed costs ($2.182) than broilers fed Availa-Zn ($1.996) or Mintrex Zn ($1.963) with a monetary difference of $0.19 and $0.22 per bird, respectively.

Table 1.
Bone Zn Levels (ppm)

<table>
<thead>
<tr>
<th>Group</th>
<th>28-d</th>
<th>42-d</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCON</td>
<td>176.48a</td>
<td>120.69a</td>
</tr>
<tr>
<td>NCON</td>
<td>123.20d</td>
<td>99.94b</td>
</tr>
<tr>
<td>ZnSO₄</td>
<td>159.15b</td>
<td>110.56a</td>
</tr>
<tr>
<td>KeyShure® Zinc</td>
<td>154.65bc</td>
<td>115.75a</td>
</tr>
<tr>
<td>Availa-Zn</td>
<td>165.10b</td>
<td>113.64a</td>
</tr>
<tr>
<td>Mintrex Zn</td>
<td>142.65c</td>
<td>112.73a</td>
</tr>
<tr>
<td><strong>SEM</strong></td>
<td>7.5984</td>
<td>2.8280</td>
</tr>
</tbody>
</table>

- Highest bone Zn concentrations were observed at 28d and 42d in the PCON group.
- Availa-Zn and ZnSO₄ had greater (p < .05) femur Zn at 28d than Mintrex Zn. At 28d and 42d, KeyShure Zinc femur Zn levels were similar to Availa-Zn, Mintrex Zn and ZnSO₄.

Table 2.
Mortality (%)

<table>
<thead>
<tr>
<th>Group</th>
<th>28-d</th>
<th>42-d</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCON</td>
<td>3.50a</td>
<td>4.00a</td>
</tr>
<tr>
<td>NCON</td>
<td>13.00bc</td>
<td>14.00b</td>
</tr>
<tr>
<td>ZnSO₄</td>
<td>20.50c</td>
<td>23.50c</td>
</tr>
<tr>
<td>KeyShure® Zinc</td>
<td>11.00bc</td>
<td>11.50b</td>
</tr>
<tr>
<td>Availa-Zn</td>
<td>11.50bc</td>
<td>12.50b</td>
</tr>
<tr>
<td>Mintrex Zn</td>
<td>12.50bc</td>
<td>14.00b</td>
</tr>
<tr>
<td><strong>SEM</strong></td>
<td>0.0221</td>
<td>0.0255</td>
</tr>
</tbody>
</table>

- Mortality at 42d for the three chelated Zn sources were not different.
- The three chelated sources had fewer deaths than ZnSO₄.
Balchem Research Summary

KeyShure — Delivers animal performance in the presence of Antagonists


Summary written by B.A Barton, Ph.D., Research and Product Development Manager, Balchem Corporation, New Hampton, NY.
Background

IP6 (inositol hexaphosphate), also known as phytate, is a naturally occurring polyphosphorylated carbohydrate found in many feedstuffs including cereal grains, corn, and wheat bran. At least 97% of the inositol phosphates contained in grains occurs as IP6. Phytate is a known trace mineral antagonist. It binds with a trace mineral, such as Zinc (Zn), and reduces its availability to the animal. The reduced mineral bioavailability can negatively impact animal performance (e.g. weight gain, feed to gain ratio, mortality). In commercial monogastric diets, the enzyme phytase is often added to the diet to break down phytate and minimize its impact on animal performance. Even in this situation, phytase addition does not break down all the phytate. Organic trace minerals are fed to overcome the effect of antagonist(s) in the diet and restore animal performance.

Balchem has helped develop a broiler chick experimental model in which a diet containing known amounts of an antagonist is supplemented with Zn from either Zinc sulfate (ZnSO₄) or KeyShure® Zinc and broiler performance is monitored. The model is based on the principle that if supplemental zinc is able to mitigate negative effects on broiler growth and feed to gain ratio in the presence of phytate, then it is effectively able to resist binding by the antagonist and thus have higher bioavailability.

Previously, KeyShure Zinc, when fed as part of a broiler diet using cottonseed hulls (CSH) as an antagonist, restored broiler chick weight gain and feed to gain ratio to levels comparable to that achieved in the positive control treatment (Sims and de Veth, 2008). CSH contain two antagonists: phytate and gossypol. The decision to use phytate in the most recent work, instead of CSH, was based on the fact that phytate addition allows a more precise addition of a known amount of antagonist to the diet. The information reported below is from a broiler chick experiment where phytate was used as the antagonist.

General Experimental Design

Broiler chicks (Hubbard x Cobb) were fed diets containing no phytate or phytate (0.15% IP6) with or without supplemental Zn (to provide an additional 40 ppm) from either ZnSO₄ or KeyShure Zinc. The single phase Corn/Soy based diets were balanced to provide: 20% CP, 1400 kcal/lb Poultry ME, and 5.0 % fat. Basal diet Zn levels were 25 ppm.

<table>
<thead>
<tr>
<th>Treatment ID</th>
<th>Trace Mineral Source</th>
<th>Antagonist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Control</td>
<td>Basal Zn</td>
<td>0</td>
</tr>
<tr>
<td>Phytate</td>
<td>Basal Zn</td>
<td>+</td>
</tr>
<tr>
<td>Phytate/ZnSO₄</td>
<td>Basal Zn plus ZnSO₄ – 40 ppm</td>
<td>+</td>
</tr>
<tr>
<td>Phytate/KeyShure® Zinc</td>
<td>Basal Zn plus KeyShure® Zinc – 40 ppm</td>
<td>+</td>
</tr>
</tbody>
</table>

The feeding period was 12 days (1 day of age starting on day 0). Hubbard x Cobb broiler chicks were used with 8 replicates of 20 birds/pen for each treatment.

Figure 1. Body weight (d 12) for the positive control (NO IP6) vs. the diets containing the antagonist and either no added Zn (IP6), ZnSO₄ (IP6/ZnSO₄) or KeyShure Zinc (IP6/KeyShure Zinc) treatments. Performance of the broilers for the positive control treatment was set to 100 and all others treatments compared to it.
Figure 2 illustrates feed/gain (d 12) for the positive control feed/gain (d 12) for the positive control (NO IP6) vs. the diets containing the antagonist and either no added Zn (IP6), ZnSO₄ (IP6/ZnSO₄) or KeyShure Zinc (IP6/KeyShure Zinc) treatments. Performance of the broilers for the positive control treatment was set to 100 and all others treatments compared to it. Lower the value = better the performance.

Results/Discussion

Figure 1. Addition of the antagonist to the diet depressed growth by approximately 7% (p<.0001) vs. the Positive Control treatment. When ZnSO₄ was added to the diet containing the antagonist, weight gain was not restored and growth was depressed by approximately 6%. Only the addition of KeyShure Zinc, to the diet containing the antagonist, was able to restore weight gain to levels obtained on the positive control treatment. This indicates that KeyShure Zinc was more available than inorganic Zn in the presence of the antagonist phytate and it was able to improve broiler growth.

Figure 2. Addition of the antagonist to the diet improved (p<.0004) feed to gain ratio by 5% vs. the positive control treatment. When ZnSO₄ was added to the diet containing the antagonist, the feed to gain ratio was still greater. Only the addition of KeyShure Zinc to the diet was able to restore the feed to gain ratio to levels obtained with the positive control diet. This also indicates that KeyShure Zinc was more available in the presence of the antagonist phytate and it was available to support a more efficient level of feed conversion than inorganic Zn.

Conclusion

• Phytate, as expected, proved to be an effective antagonist because it reduced growth rate and feed to gain ratio when added to the basal diet.
• The differences between Zn sources are amplified in the presence of antagonists. KeyShure Zinc, because of its higher bioavailability, permitted the broilers to achieve better growth and feed conversion.
• These results, along with the Sims and De Veth (2008) study confirms that KeyShure Zinc supplementation can overcome the negative impact of antagonists on animal performance.