Determination of a Relative Bioavailability Value for KemTRACE® Zinc Propionate versus Zinc Sulfate

This study was conducted to determine the relative bioavailability value (RBV) of KemTRACE® Zinc Propionate (ZnProp) compared to zinc sulfate (ZnSO₄) as defined in a depletion/repletion assay. The bioavailable zinc concentration in the soy protein concentrate (SPC) basal diet was estimated to be 8.8 mg/kg. The SPC basal diet was supplemented with 4, 8, and 12 mg/kg from zinc sulfate and compared to diets supplemented with 4, 8, and 12 mg/kg of KemTRACE Zinc Propionate.

The 12 mg/kg zinc propionate treatment had a significant positive response (P<0.0001) on weight gain at the conclusion of the study when compared to the other six treatments. A similar trend was noted for feed conversion ratio, where the 12 mg/kg inclusion level of zinc propionate was significantly lower (P<0.001) than each level of the zinc sulfate diets fed. Slope ratio analysis using weight gain (g) resulted in a RBV of 100% and 143% for the zinc sulfate and zinc propionate, respectively, while using total tibia zinc as the response parameter resulted in a RBV of 100% and 184% for the zinc sulfate and zinc propionate, respectively. Based on the results of this study, the conservative recommendation replacement value for KemTRACE® Zinc Propionate for broilers is 50% when replacing an inorganic zinc sulfate source.

KEYWORDS: Relative Bioavailability, KemTRACE® Zinc Propionate, Zinc Sulfate

Introduction
The National Research Council (1994) has established recommended levels of zinc in broiler, dairy, swine and beef cattle diets of 20-100 ppm to ensure a proper level of zinc. Zinc has been found to be a critical element in the proper functioning of several key enzymes. Wedekind et al. (1992) suggested that organic mineral sources are more bioavailable than inorganic sources.

Zinc is supplemented in most commercial poultry diets either as ZnSO₄·H₂O (36% Zn) or ZnO (72% Zn), with ZnO being less bioavailable than ZnSO₄ from the former (Wedekind and Baker, 1990). Data in the literature would also suggest that both weight gain and total tibia Zn could be used as criteria of Zn efficacy because Wedekind et al. (1992) showed that these measures of chick performance would respond linearly to graded levels of Zn that are added to a Zn-deficient soy concentrate diet. In recent years, organic forms of trace minerals, which are considered highly bioavailable, are being used in combinations with inorganic sources to increase the delivery of target minerals. KemTRACE® Zinc Propionate is one of the organic forms of trace mineral supplements for animals developed by Kemin.

Our objective for this trial was to evaluate and then compare the relative bioavailability of KemTRACE® Zinc Propionate to zinc sulfate utilizing a broiler model.

Methods and Materials
Two hundred and ten (210) commercial broiler male chicks (Ross 308) from a commercial hatchery with an average initial weight of 70g were fed a nutritionally complete corn-soybean meal diet for the first 3 days post-hatching in this study. Then the chicks were switched to a Zn-deficient soy protein concentrate basal diet and fed this diet until day 7 post-hatching. After being subjected to overnight feed withdrawal, chicks were weighed, wing banded and allotted to stainless steel battery cages with temperature and light adjusted to age requirements making sure that each pen had a similar initial weight. Feed and water was available ad libitum, and there was no vaccination, antibiotic or coccidiostat program incorporated in the study design. Growth performance, body weight, body weight gain, and feed conversion were calculated from
measurements collected at days 8 and 20 (end of the experiment). Six replicate groups of five chicks were fed one of 7 treatment diets for 12 days. The basal diet was not supplemented with added zinc. Corn starch was used as an ingredient to be substituted as the different additions of zinc were made.

**Results and Discussion**

Weight gain, feed intake and feed to gain are illustrated in Table 1. The three measures responded linearly with increased levels of zinc as suggested by Wedekind et al. (1992), with zinc propionate treatments performing better than their Zn sulfate counterparts. Overall the 12 mg/kg zinc propionate treatment had a significant positive response (P<0.0001) on weight gain at the conclusion of the study when compared to the other six treatments. A similar trend was noted for feed conversion where the 12 mg/kg inclusion level of zinc propionate was significantly lower (P<0.0001) than each level of zinc sulfate fed.

**Table 1: Weight gain, feed intake and feed conversion (feed/gain) for 7-18 days (g/chick)**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>4 ppm ZnSO₄</th>
<th>8 ppm ZnSO₄</th>
<th>12 ppm ZnSO₄</th>
<th>4 ppm ZnProp</th>
<th>8 ppm ZnProp</th>
<th>12 ppm ZnProp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight gain, mean</td>
<td>199.9ᵃ</td>
<td>254.1ᵇ</td>
<td>301.9ᶜ</td>
<td>344.3ᵇ</td>
<td>302.3ᵇ</td>
<td>359.1ᵇ</td>
<td>403.7ᵃ</td>
</tr>
<tr>
<td>Feed intake</td>
<td>280.3ᵃ</td>
<td>339.2ᵈ</td>
<td>378.5ᶜ</td>
<td>431.7ᵇ</td>
<td>375.2ᵇ</td>
<td>444.1ᵇ</td>
<td>477.1ᵃ</td>
</tr>
<tr>
<td>Feed/gain g/g</td>
<td>1.4₀ᵃ</td>
<td>1.33ᵇ</td>
<td>1.25ᶜ</td>
<td>1.25ᶜ</td>
<td>1.24 cd</td>
<td>1.23 cd</td>
<td>1.18ᵈ</td>
</tr>
</tbody>
</table>

a,b,c,d,e Values within rows with different superscripts are significantly different (P<0.001).

Tables 2 and 3 detail the data for bone zinc measurements that were used in the calculations of the RBV. On a net value the zinc weights reflected the growth parameters in Table 1 and 2, where weights were greater for the higher inclusion levels of zinc and also greater for the zinc propionate treatments. The slope ratio analysis using weight gain (g) resulted in a RBV of 100% and 143.3% for zinc sulfate and zinc propionate, respectfully. Utilizing the total tibia zinc as the response parameter resulted in a RBV of 184% for zinc propionate. Zinc propionate when fed at 12 ppm resulted in a significantly (P<0.001) improved weight gain response when compared with all other treatments. KemTRACE® Zinc Propionate when fed at 8 ppm resulted in equal weight gain performance to Zn Sulfate fed at 12 ppm. Zinc propionate when fed at 4 ppm resulted in equal weight gain performance compared to Zn Sulfate fed at 8 ppm. Zinc propionate when fed at 12 ppm resulted in significantly lower feed to gain ratio (P<0.0001), compared to all Zn Sulfate treatments.

**Table 2: Tibia bone measurements**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>4 ppm ZnSO₄</th>
<th>8 ppm ZnSO₄</th>
<th>12 ppm ZnSO₄</th>
<th>4 ppm ZnProp</th>
<th>8 ppm ZnProp</th>
<th>12 ppm ZnProp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry bone wt. (mg/tibia)</td>
<td>671.9ᵃ</td>
<td>786.7ᵈ</td>
<td>934.6ᶜ</td>
<td>1019.9ᵇ</td>
<td>936.2ᶜ</td>
<td>1071.6ᵇ</td>
<td>1165.1ᵃ</td>
</tr>
<tr>
<td>Bone ash, (mg/tibia)</td>
<td>323.1ᵃ</td>
<td>387.6ᵈ</td>
<td>471.3ᶜ</td>
<td>514.1ᵇ</td>
<td>469.3ᶜ</td>
<td>545.6ᵇ</td>
<td>589.3ᵃ</td>
</tr>
<tr>
<td>Bone ash, (%)</td>
<td>48.1ᶜ</td>
<td>49.2ᵇ</td>
<td>50.4ᵃ</td>
<td>50.4ᵃ</td>
<td>50.1ᵇ⁻</td>
<td>50.9ᵃ</td>
<td>50.5ᵃ</td>
</tr>
</tbody>
</table>

a,b,c,d,e Values within rows with different superscripts are significantly different (P<0.0001).

**Table 3: Tibia zinc, total tibia zinc and supplemental zinc intake measurements**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>4 ppm ZnSO₄</th>
<th>8 ppm ZnSO₄</th>
<th>12 ppm ZnSO₄</th>
<th>4 ppm ZnProp</th>
<th>8 ppm ZnProp</th>
<th>12 ppm ZnProp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplemental Zinc, (mg)</td>
<td>0</td>
<td>1.37</td>
<td>3.04</td>
<td>5.19</td>
<td>1.51</td>
<td>3.57</td>
<td>5.74</td>
</tr>
<tr>
<td>Zinc (µg/g of bone ash)</td>
<td>53.79</td>
<td>60.73</td>
<td>73.57</td>
<td>82.39</td>
<td>69.86</td>
<td>91.41</td>
<td>115.60</td>
</tr>
<tr>
<td>Total tibia Zn (µg Zn/Tibia)</td>
<td>17.39</td>
<td>23.56</td>
<td>34.75</td>
<td>42.40</td>
<td>32.87</td>
<td>49.98</td>
<td>68.09</td>
</tr>
</tbody>
</table>
Slope Ratio Method

Using weight gain (g) as a response
Relative Bioavailability to Standard (ZnSO₄)
RBV of ZnSO₄ = 23.75/23.75 = 1*100 = 100.0%
RBV of Test Zn Compound = 34.05/23.75 = 1.433*100 = 143.3%

Using total tibia zinc (µg Zn/Tibia) as a response parameter
Relative Bioavailability to Standard (ZnSO₄)
RBV of ZnSO₄ = 4.79/4.79 = 1*100 = 100.0%
RBV of Test Zn Compound = 8.77/4.79 = 1.842*100 = 184.2%

Conclusions
The results of this depletion/repletion study indicated that KemTRACE® Zinc Propionate provided more bioavailable zinc than zinc sulfate. The 12 mg/kg zinc propionate treatment had a significant positive response (P<0.0001) on weight gain at the conclusion of the study when compared to the other six treatments. A similar trend was noted for feed conversion ratio where the 12 mg/kg inclusion level of zinc propionate was significantly lower (P<0.0001) than each level of zinc sulfate fed. Slope ratio analysis using weight gain (g) resulted in a RBV of 100% and 143% for the zinc sulfate and zinc propionate, respectively. While using total tibia zinc as the response parameter resulted in a RBV of 100% and 184% for the zinc sulfate and zinc propionate, respectively. Based on the results of this study, the conservative recommendation replacement value for KemTRACE® Zinc Propionate for broilers is 50% when replacing an inorganic Zinc Sulfate source.

References