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Determination of the Relative Bioavailability for Zinc and Butyric Acid as Compared to Zinc Sulfate[1]

Broilers are grown in environments constantly challenging the health of the birds.

By adding ButiPEARL™ Z, at 500 ppm to broiler diets, it is possible to:

- Provide the amount of zinc required by the poultry National Research Council.
- Provide a bioavailable source of zinc which increases the absorption and utilization of zinc in the broiler.

The complementary actions of butyric acid and zinc can provide improvements to support production efficiency and healthier birds.

ABSTRACT

This study evaluated the relative bioavailability of zinc provided by zinc and butyric acid, the active ingredient in ButiPEARL™ Z. The effect of zinc and butyric acid on zinc bone deposition was determined in Cobb 500 broiler chicks fed a semi-purified diet low in zinc, consisting of soy protein concentrate, dextrose and corn starch (24 mg/kg of background Zn). Eleven replicate groups of 8 chicks were fed the experimental diets from 0 through 21 days of age. The control diet was supplemented with zinc and butyric acid or zinc sulfate at 4, 8, 12 or 16 mg/kg of feed, for a total of eight experimental treatments and one control. The parameters evaluated in this study were feed consumption, body weight gain, mortality corrected feed conversion ratio (FCR) and tibia zinc concentration. From the tibia zinc slope-ratio calculation, it was determined the zinc ion in the combination of zinc and butyric acid (slope = 10.4 ± 0.5, R^2 = 0.91) was 19.0 ± 9.5 % more bioavailable than the zinc ion in zinc sulfate (slope = 8.7 ± 0.6, R^2 = 0.81). The higher deposition of the zinc from zinc and butyric acid suggests it may be a replacement for organic and inorganic zinc, especially when the butyric acid component can support improved performance if fed at the recommended level (200 g zinc and butyric acid/MT, which provides 55 ppm Zn and 154 ppm butyric acid).

INTRODUCTION

Zinc, an essential mineral, plays a role in many biological processes such as growth, metabolism, immunity and intestinal integrity[2]. Zinc supplementation is commonly achieved by feeding an inorganic source such as zinc oxide (ZnO) or zinc sulfate ($ZnSO_4$), or as an organic source in which zinc is bound to a ligand such as propionate or methionine. Different sources of zinc can have varying levels of bioavailability, in that organic sources of zinc are more bioavailable (~25% more) than zinc from inorganic sources[3].

Butyric acid has been shown to have roles in the proliferation and differentiation of intestinal cells, tight junction maintenance[4,5]. Typically, butyric acid is fed in the salt form with calcium or sodium. However, the uncoated form of dietary butyric acid or its salts are absorbed early in the esophagus and crop and is associated with an unpleasant odor that can lead to lowered intakes and manufacturing challenges. The development of encapsulation and coating procedures can reduce the associated unpleasant odor. Kemin Industries (Des Moines, IA, USA) produces an encapsulated butyric acid (ButiPEARL™) through the MicroPEARLS® brand spray freezing process which reduces odor and provides a slower release in the gastrointestinal tract[6].

Encapsulated zinc and butyric acid provides the essential trace mineral zinc while the butyric acid benefits gut health and supports performance. The objective for this trial was to determine the relative bioavailability of powdered zinc and butyric using $ZnSO_4$ as the bioavailability standard.

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MATERIALS AND METHODS

Seven hundred and ninety two (792) male broiler chicks (Cobb × Cobb 500) from a commercial hatchery, with an average weight of 41.9 g, were divided into 99 cages of 8 chicks. The trial consisted of 9 treatments replicated in 11 blocks with the 9 treatments randomized within each block. The chicks were placed in stainless steel batteries and fed the treatment diets from 0 to 21 days. The treatments were based on a semi-purified diet low in zinc, consisting of soy protein concentrate, dextrose and corn starch (24 mg/kg of background Zn). The control diet was supplemented with zinc and butyric acid or zinc sulfate at 4, 8, 12 or 16 mg/kg of feed. Feed and water were provided *ad libitum*. Birds and feed were weighed on day 7, 14 and 21. On day 21, tibias were harvested. Feed and tibia bone ash were analyzed for zinc. The zinc content was determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). For the feed samples, the zinc values for triplicate samples were averaged. The averaged zinc value for the control diet was then subtracted from the average zinc value for each treatment to yield the supplemented zinc value for each treatment. The tibia zinc concentrations for each cage were plotted versus the measured supplemental zinc concentrations for each diet. The plots were fitted using linear regression (JMP®, SAS Institute Inc.).

RESULTS

Tibia bone measurements relative to ZnSO4 (Figure 1A) and zinc and butyric acid (Figure1B) are shown below. Table 1 shows the comparison of the slopes for the data of the zinc sulfate diets and the zinc and butyric acid diets.

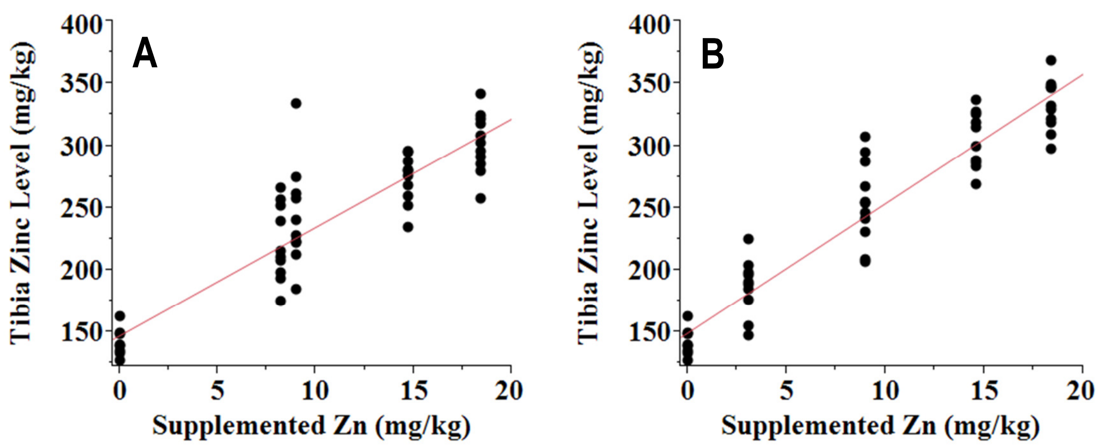

Figure 1. Dose response plots for tibia zinc levels. A) ZnSO4 linear fitting: Slope = 9.43 ± 0.70; Intercept = 159.8 ± 6.9; R^2 = 0.77. B) Zinc and Butyric Acid linear fitting: Slope = 12.61 ± 0.56; Intercept = 142.8 ± 5.5; R^2 = 0.90.

Table 1. Parameters from the fitting of the tibia zinc level data.

Parameter	$ZnSO_4$	Zinc and Butyric Acid
Slope	8.72 ± 0.58	10.41 ± 0.46
Intercept	147.5 ± 6.8	149.8 ± 5.1
R^2	0.81	0.91
% Improvement in Bioavailability	–	19.0 ± 9.5%

CONCLUSIONS

The plots for the ZnSO4 and zinc and butyric acid treatments show significant positive slopes. Fitting the data using linear regression shows these slopes are different (Figure 1, Table 1). The data shows the zinc and butyric acid powder may be

19% more bioavailable than the $ZnSO_4$ powder (Table 1). Feeding the recommended level of zinc and butyric acid (200 g of zinc and butyric acid/MT feed) could provide necessary butyric acid to support improvement of FCR and body weight[7] and exceed the National Research Council minimal requirement of 40 mg/kg of feed[8].

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