

Dietary Factors Affecting Zinc Bioavailability, and Zinc Bioavailability in Tetrabasic Zinc Chloride

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Tetrabasic Zinc Chloride (TBZC)



Zn = 60.2%



Introduction

- Zinc is commonly added as a supplement to all formulated poultry diets as zinc oxide or zinc sulfate
- Sulfates are highly water soluble, more reactive than oxides
- Tribasic copper chloride, minimal oxidation during feed storage (Miles *et al.*, 1998)
- Cao *et al.* (2000) reported a relative Zn bioavailability estimate of 107% for TBZC

Objective

- To determine the relative bioavailability (RBV) of Zn in tetrabasic Zn chloride [$\text{Zn}_5\text{Cl}_2(\text{OH})_8$]
- To evaluate factors affecting Zn utilization and the Zn requirement

Materials and Methods

- A standard 23% CP corn-SBM diet was fed during the first 4 d posthatching and was replaced by a Zn-deficient soy concentrate diet until d 8
- New Hampshire x Columbian chicks
- 4 pens/treatment (4 chicks/pen) allowed *ad libitum* access to experimental diets (d 8- 22)
- Stainless-steel batteries, waterers, feeders and mixing equipment

Soy Concentrate Basal Diet¹

Ingredient	%
Dextrose	36.95
Soy concentrate	31.00
Soybean oil	5.00
Zn-free mineral mix	5.37
DL-Methionine	0.20
L-Threonine	0.10
Vitamin Premix	0.20
Choline Chloride	0.20
DL- α -Tocopheryl acetate (20 mg/kg)	+
Ethoxyquin (125 mg/kg)	+
Cornstarch	to 100

¹ Contained 13.5 mg Zn/kg (8.8 mg/kg bioavailable Zn)

Materials and Methods

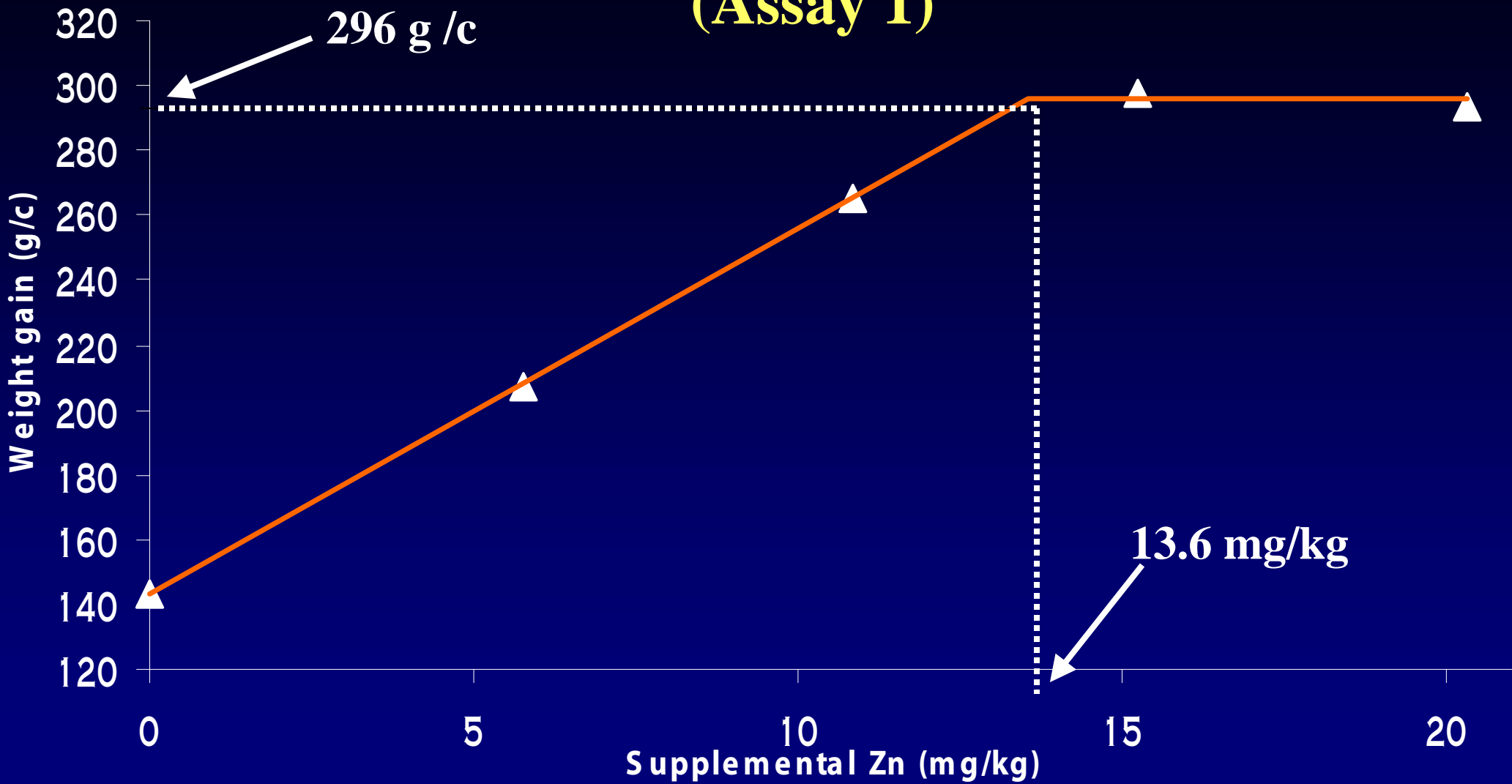
- Assay 1: Basal diet was supplemental with 0, 5.81, 10.81, 15.10, and 20.25 mg Zn/kg from analytical-grade $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$
- Assays 2 and 3: Basal diet supplemented with analytical-grade $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ or TBZC [$\text{Zn}_5\text{Cl}_2(\text{OH})_8$] to produce a linear response range
 - Weight gain was evaluated as a function of supplemental Zn intake, and multiple-linear regression (slope-ratio) methodology was used to calculate an RBV value for TBZC

Materials and Methods

- Assay 4: Basal diet was supplemented with graded levels of analytical-grade $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ with or without the addition of 250 mg/kg of ascorbic acid
- Assay 5: Basal diet was supplemented with graded levels of analytical-grade $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ with or without the addition of 1% excess calcium from CaCO_3

Bioavailable Zinc Requirement of Chicks

(Assay 1)



Minimum bioavailable Zn requirement of 22.4 mg Zn/kg

Zn Bioavailability in Tetrabasic Zn Chloride Relative to Zn Sulfate Heptahydrate (Assay 2)

Supplemental Zn		Supplemental		
Level (mg/kg)	Source	Weight gain (g) ¹	Feed intake (g)	Zn intake (mg)
0	_____	145	317	0
5.81	ZnSO ₄ •7H ₂ O	220	401	2.33
10.81	ZnSO ₄ •7H ₂ O	279	495	5.36
5.38	Zn ₅ Cl ₂ (OH) ₈	224	422	2.72
10.81	Zn ₅ Cl ₂ (OH) ₈	276	481	5.20
SEM		7	12	

¹ Y=155.8 + 23.8x₁ + 24.3x₂ (R² = 0.93); x₁ = ZnSO₄•7H₂O, x₂ = TBZC.

Zn Bioavailability in Tetrabasic Zn Chloride Relative to Zn Sulfate Heptahydrate (Assay 3)

Supplemental Zn		Supplemental		
Level (mg/kg)	Source	Weight gain (g) ¹	Feed intake (g)	Zn intake (mg)
0	_____	80	279	0
5.92	ZnSO ₄ •7H ₂ O	140	304	1.80
10.78	ZnSO ₄ •7H ₂ O	199	392	4.23
5.41	Zn ₅ Cl ₂ (OH) ₈	141	316	1.71
10.82	Zn ₅ Cl ₂ (OH) ₈	208	370	4.01
SEM		6	10	

¹Y = 85.2 + 27.7x₁ + 30.6x₂ (R² = 0.94); x₁ = ZnSO₄•7H₂O, x₂ = TBZC.

Relative Bioavailability Values for Zn (%)

Standard

Sources of Zn

ZnSO₄·7H₂O (AG)

ZnSO₄·H₂O (FG)

ZnSO₄·7H₂O (AG)

100

115

ZnSO₄·H₂O (FG)¹

87

100

Zn₅Cl₂(OH)₈²

107

122

ZnO (HS)¹

95

109

ZnO (W)¹

37

46

¹ Edwards and Baker (1999)

² Corless *et al.* (2000)

Zn Requirement Estimates for Chicks Fed a Corn-SBM diet

Source of Zn	Estimated Total Zn requirement (mg/kg)
ZnSO ₄ •7H ₂ O	25.7
ZnSO ₄ •H ₂ O	27.5
Zn ₅ Cl ₂ (OH) ₈	24.9
ZnO (W)	46.5

Data calculated from Corless *et al.* (2000), Edwards and Baker (1999), and Edwards and Baker (2000)

Other Factors Evaluated

- Ascorbic Acid
 - RBV of Zn in the presence of 250 mg ascorbic acid/kg was 79.6%
- Calcium
 - RBV of Zn in the presence of 1% excess Calcium was 97.1

Conclusions

- When a SPC -dextrose diet was fed, the bioavailable Zn requirement was 22.4 mg Zn/kg (total dietary Zn requirement of 27 mg Zn/kg)
- Bioavailability of Zn in TBZC was estimated to be the same as that in analytical-grade Zn sulfate

Conclusions

- Many factors can affect the Zn requirement of chicks:
 - Dietary ingredients: phytate, fiber, ascorbate, cysteine, Ca, organic acids, oxalates
 - Sources of inorganic Zn used in requirement bioassay