

# Vitamin & Mineral Formulations: Current & Future Considerations

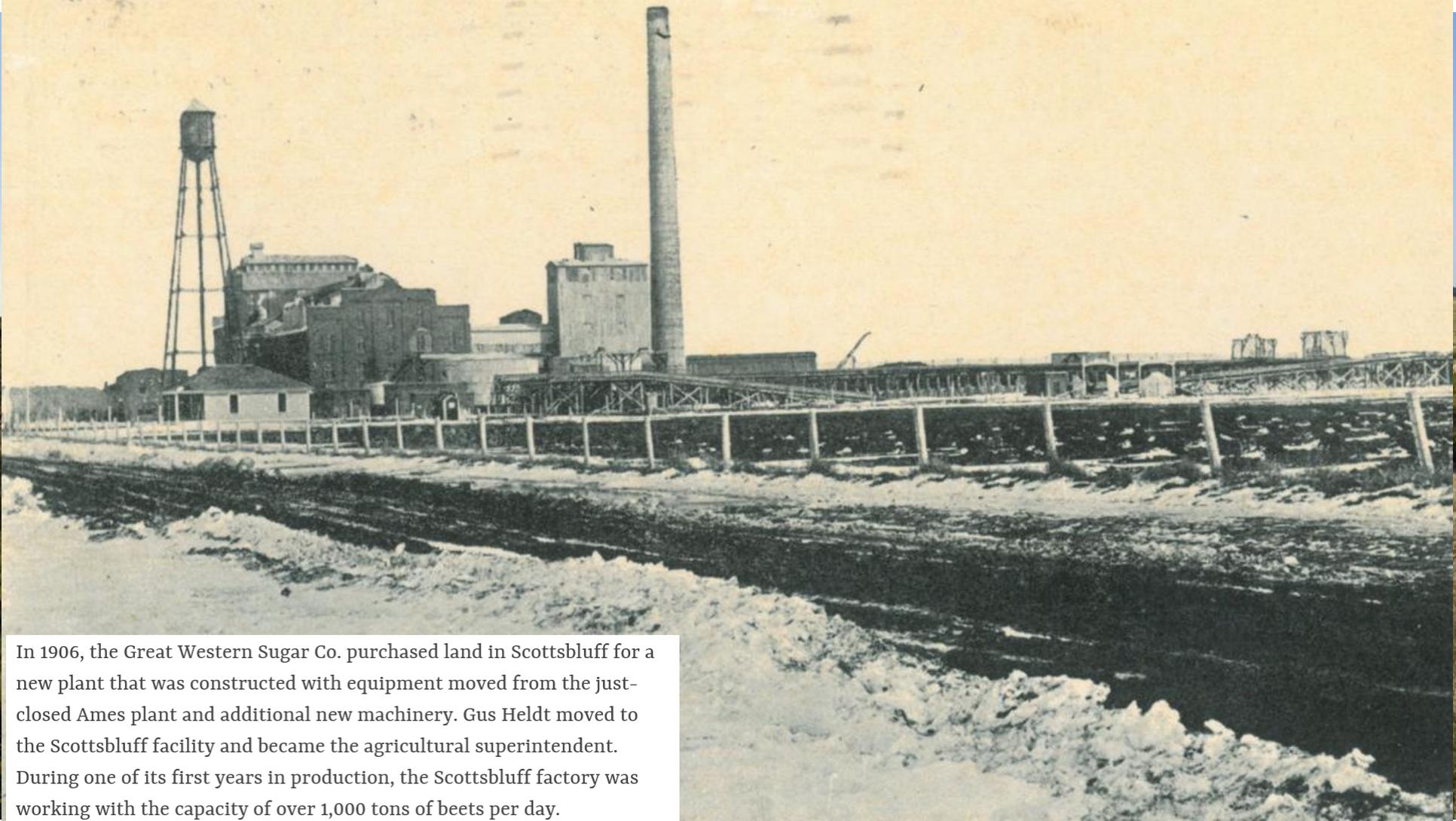
Jeff Heldt, PhD PAS

Beef Technical Services Manager

Micronutrients USA LLC



# Scottsbluff Sugar Factory, Scottsbluff, Neb.



In 1906, the Great Western Sugar Co. purchased land in Scottsbluff for a new plant that was constructed with equipment moved from the just-closed Ames plant and additional new machinery. Gus Heldt moved to the Scottsbluff facility and became the agricultural superintendent. During one of its first years in production, the Scottsbluff factory was working with the capacity of over 1,000 tons of beets per day.



# Topics

- **Current Situation**
- **Role of Vitamin Review (Brief)**
- **Vitamin Requirements**
- **Feedstuff Vitamins**
- **Other Factors that May Impact Vitamins**
- **Conclude**
- **WHY**
  - **Competitive Cost of Production**
  - **Normalization of Deviance**



# Situation

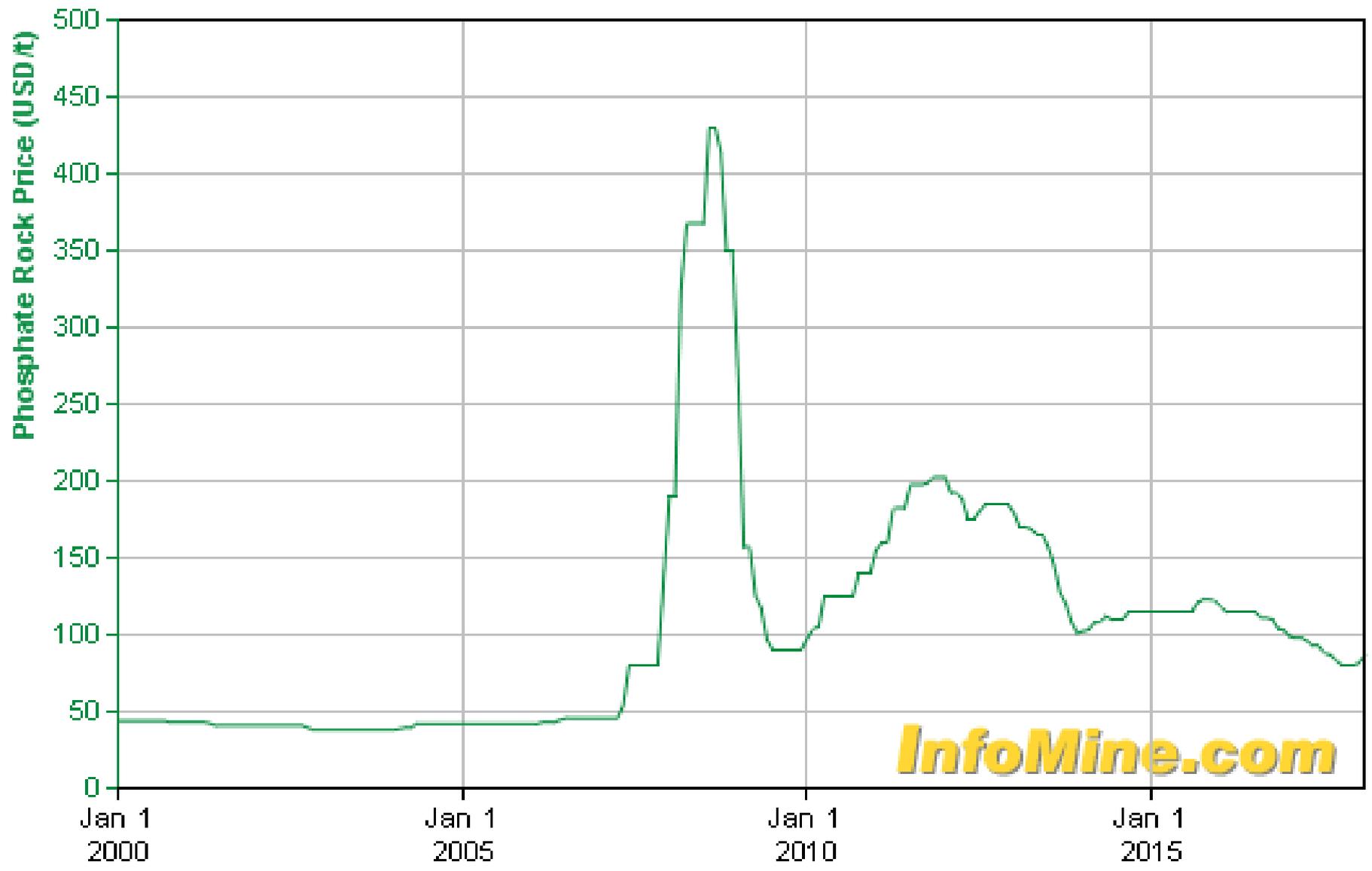
- **October 31, 2017**
  - **Fire affected BASF factory in Germany**
  - **This facility produces nearly 50% of the worlds global feed grade vitamin A precursors and some vitamin E precursors**
  
- **July 2, 2018**
  - **BASF lifted Force Majeure for its vitamin A & E products**  
[\(unforeseeable circumstances that prevent someone from fulfilling a contract\)](#)
  - **BASF confirmed that the ramp-up of its downstream production for animal nutrition products is going as planned**
  - **BASF still on track to build new plant by 2020**



# Phosphate Rock Price

86.00 USD/t

28 Feb '18



**InfoMine.com**

# Functions of Vitamins

- **Specific functions include:**
  - **Nurture growth; reproduction; maintain life**
  - **Prevent deficiency diseases**
  - **Help enzymes release energy from carbohydrates, lipids and proteins**



# Classification

- **Based on solubility, and solubility greatly influences how the body absorbs, transports and stores vitamins**
- **Fat-Soluble**
  - **Vitamins A, D, E and K**
- **Water-Soluble**
  - **B vitamins and vitamin C**



# Water-soluble Vitamins

Vitamin C  
(ascorbic acid)

B-complex vitamins

Energy releasing

Hematopoietic

Other

Thiamin (B<sub>1</sub>)  
Riboflavin (B<sub>2</sub>)  
Niacin (B<sub>3</sub>)  
Pantothenic acid  
Biotin  
Pyridoxine (B<sub>6</sub>)

Folic acid  
Cyanocobalamin (B<sub>12</sub>)  
Pyridoxine (B<sub>6</sub>)  
Pantothenic acid

Pyridoxine (B<sub>6</sub>)  
Thiamin (B<sub>1</sub>)  
Folic acid  
Cyanocobalamin (B<sub>12</sub>)  
Niacin (B<sub>3</sub>)

# Fat-Soluble Vitamins

<u>Vitamin</u>	<u>Chemical name</u>
A	Retinol (beta-carotene)
D <sub>2</sub>	Ergocalciferol
D <sub>3</sub>	Cholecalciferol
E	Tocopherol (alpha-tocopherol)
K	Phylloquinone

# Fat-Soluble Vitamins

- **Liver either stores the vitamin or repackages it for delivery to other cells**
  - **Excess fat soluble vitamins accumulate in liver and adipose tissue**
  - **Limited Literature = 3-6 months storage**
  - **Toxicities can occur; almost always associated with supplements (not from feeds)**



# The Fat-Soluble Vitamins

A, D, E and K



# Vitamin A Roles in the Body

- **Essential for vision (retinal)**
  - Maintenance of the cornea
  - Converting light energy into nerve impulses
  - Rod cells vs. Cone cells
- **Participate in protein synthesis and cell differentiation**
  - Differentiation of epithelial cells
- **Support reproduction and growth**
- **Support immunity (retinoic acid and carotenoids)**
- **Involved in bone growth and remodeling**
- **Synthesis of glycoproteins**
- **Antioxidant activity ( $\beta$ -carotene)**



# Vitamin A - Deficiency

- **More obvious deficiency symptoms than other vitamins**
  - **Night blindness**
    - Leading cause of blindness in third world countries
    - India and Denmark examples:
      - Butter exported and infants only given Skim Milk
  - **Cell keratinization**
    - Dry skin
    - Xerophthalmia (dryness of cornea & conjunctiva)
      - Unable to produce tears
  - **Anorexia**
  - **Reproductive failure**
  - **Abnormal skeletal development/maintenance**
  - **Immune dysfunction**



# Vitamin D - Functions

- **Functions**
  - **Bone development**
    - Calcium absorption (small intestine)
    - Calcium resorption (bone and kidney)
    - Maintain blood calcium levels
    - Phosphorus absorption (small intestine)
  - **Hormone**
    - Regulation of gene expression
    - Cell growth



# Vitamin D - Deficiency

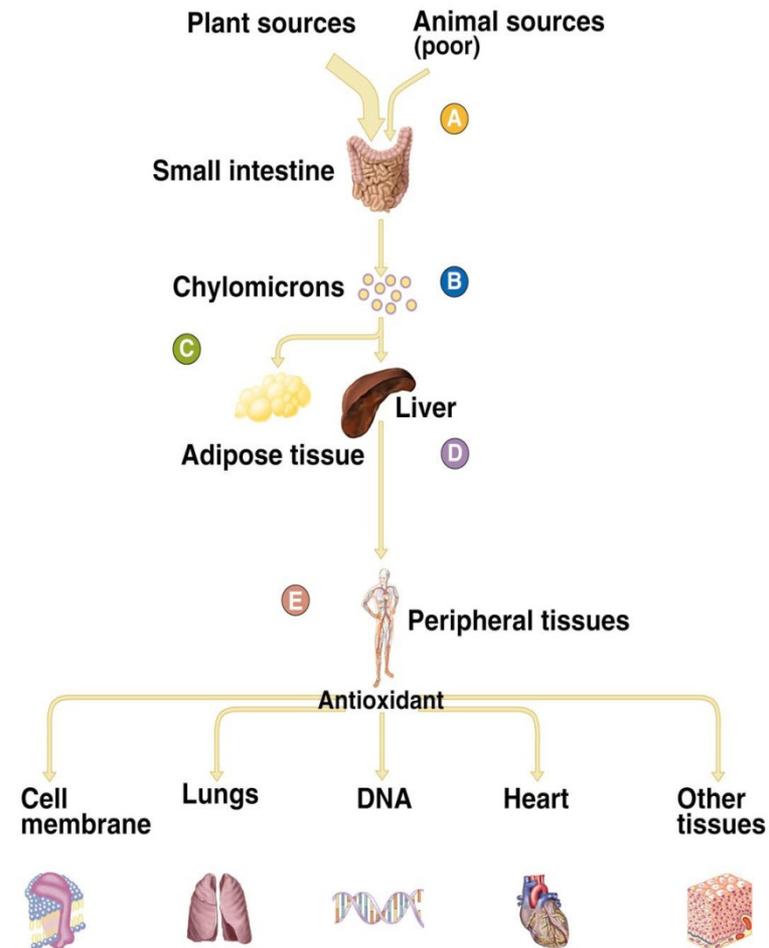
- **Young animals**
  - **Rickets**
    - Failure of bones to grow properly
    - More cartilage and less ossification (weak or flimsy bones)
    - Results in “bowed” legs or knock-knees, outward bowed chest and knobs on ribs
- **Older animals**
  - **Osteomalacia: Adult form of rickets**
    - Softening of bones, bending of spine, and bowing of legs
  - **Osteoporosis (porous bones):**
    - Vitamin D plays a major role along with calcium
    - Loss of vitamin D activity with advancing age
    - Associated with fractures → very serious for geriatrics
- **Poultry**
  - Decreased egg production & hatchability
  - Thin-shelled eggs



# Vitamin E - Functions

VITAMIN E: FROM SOURCE TO DESTINATION

- **Stabilize reactions or situations that typically produce free radicals**
  - Nucleic acid and protein metabolism
  - Mitochondrial metabolism
  - Supplementation may increase antibody production
  - When supplemented prior to slaughter, helps maintain meat quality (shelf life, color)



# Vitamin E - Deficiency

- **Rare – typically associated with fat malabsorption or excessive intake of polyunsaturated fatty acids (PUFAs)**
  - **Anemia**
  - **Retinal degeneration**
  - **Muscle weakness and incoordination (neuromuscular dysfunction)**



# New NRC – NASEM, 2016

- **Confined Cattle**

- A – No Change
- D – No Change
- E
  - Old = 15 – 60 IU/Kg DMI
  - Change = 400-500 IU/hd for Stressed Cattle



- **Removal of Vitamin A can increase marbling....Consult with Nutritionist**

# What People Asked About or What We Discussed...

- Revisit Requirements
- Feedstuff Vitamin Supply
- Pay Attention to Tags
- Trace Mineral Sources
- Storage Time



# Vitamin A Content of Feedstuffs

Feedstuff	Vitamin A Equivalent, IU/lb DM	Requirement, IU/lb DM
Fescue Pasture	18,079	1,270 - 1,769
Fescue Hay	1,325	1,270 - 1,769
Alfalfa Hay	1,321	1,270 - 1,769
Corn Silage	3,129	1,270 - 1,769
Whole Shell Corn	77	1,270 - 1,769
Steam Flaked Corn	62	1,270 - 1,769
Cracked Corn	68	1,270 - 1,769
High Moisture Corn	163	1,270 - 1,769
WDGS	363	1,270 - 1,769
DDGS	219	1,270 - 1,769

# Tag Reading

- IU/lb to IU/hd/d
- 160,000 IU/lb = ? IU/hd/d
- 4 oz/hd/d Feeding Rate
- $160,000 / 16 \text{ oz/lb} = 10,000 \text{ IU/oz}$
- $10,000 \times 4 \text{ oz} = 40,000 \text{ IU/hd/d}$



# Tag Reading

Vitamin	Req. IU/hd/d	Tag A (3 oz)	Tag B (4 oz)	Tag C (4 oz)
<b>Bred Cow (12 kg DMI)</b>				
A	33,600	300,000 (56,250)	150,000 (37,500)	250,000 (62,500)
D	3,300	30,000 (5,625)	15,000 (3,750)	5,000 (1,250)
E	180-720	50 (93.75)	150 (37.5)	250 (62.5)
<b>Lactating Cow (14 kg DMI)</b>				
A	54,600	300,000 (56,250)	150,000 (37,500)	250,000 (62,500)
D	3,850	30,000 (5,625)	15,000 (3,750)	5,000 (1,250)
E	210-840	50 (93.75)	150 (37.5)	250 (62.5)

Dry Cow A = 2,800 IU/kg DM

Lactating Cow A = 3,900 IU/kg DM

D = 275 IU/kg DM

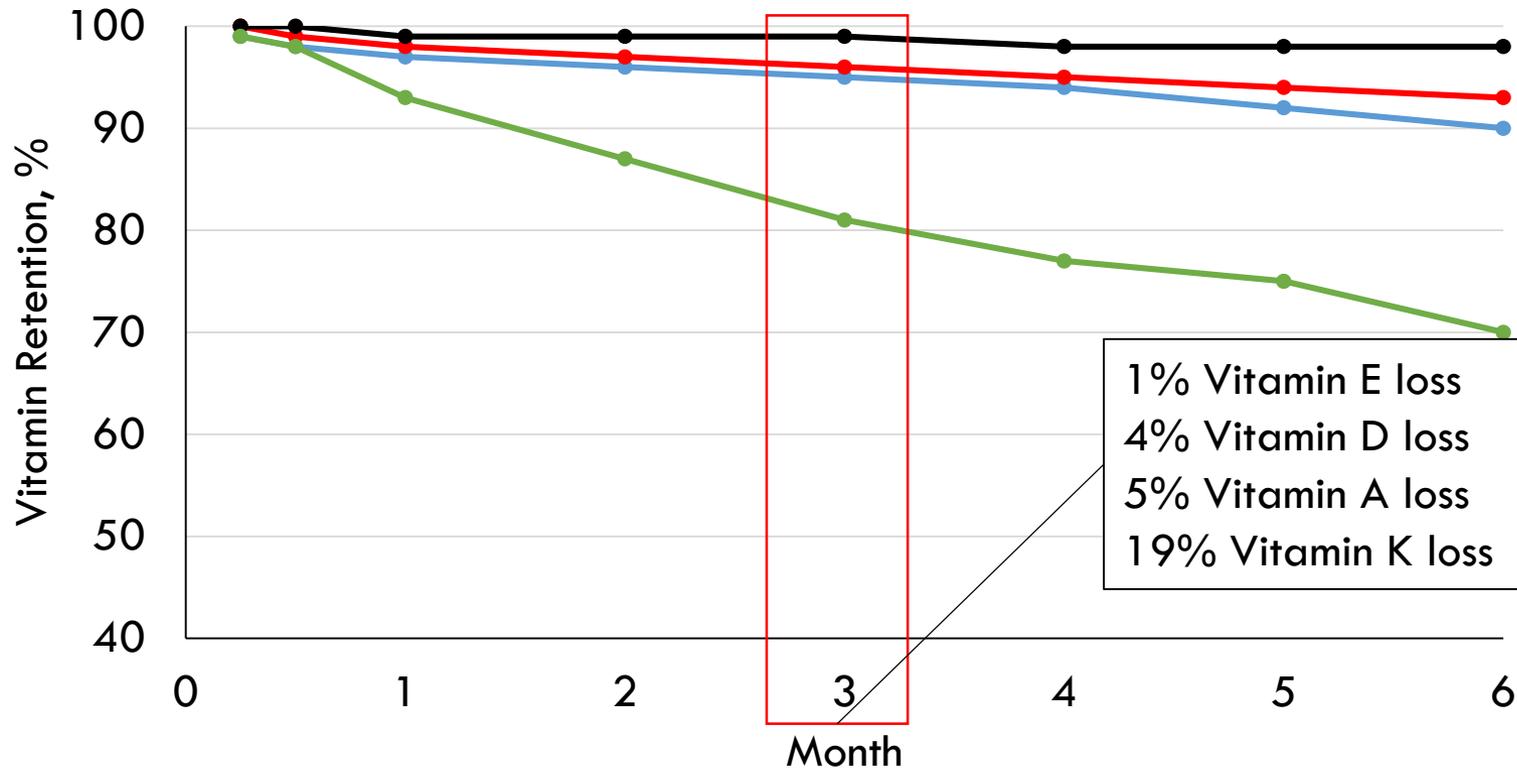
E = 15-60 IU/kg DM

# Factors that Affect Vitamin Stability

- **Water**
  - Primary Enemy
- **pH**
  - Optimum Range 6-9
- **Heat**
  - Potency Loss can Double with every 25°F Increase
    - 5% Loss of activity at 40°F = 20% Loss at 90°F
- **Minerals**
- **Other Ingredients**
- **Light**

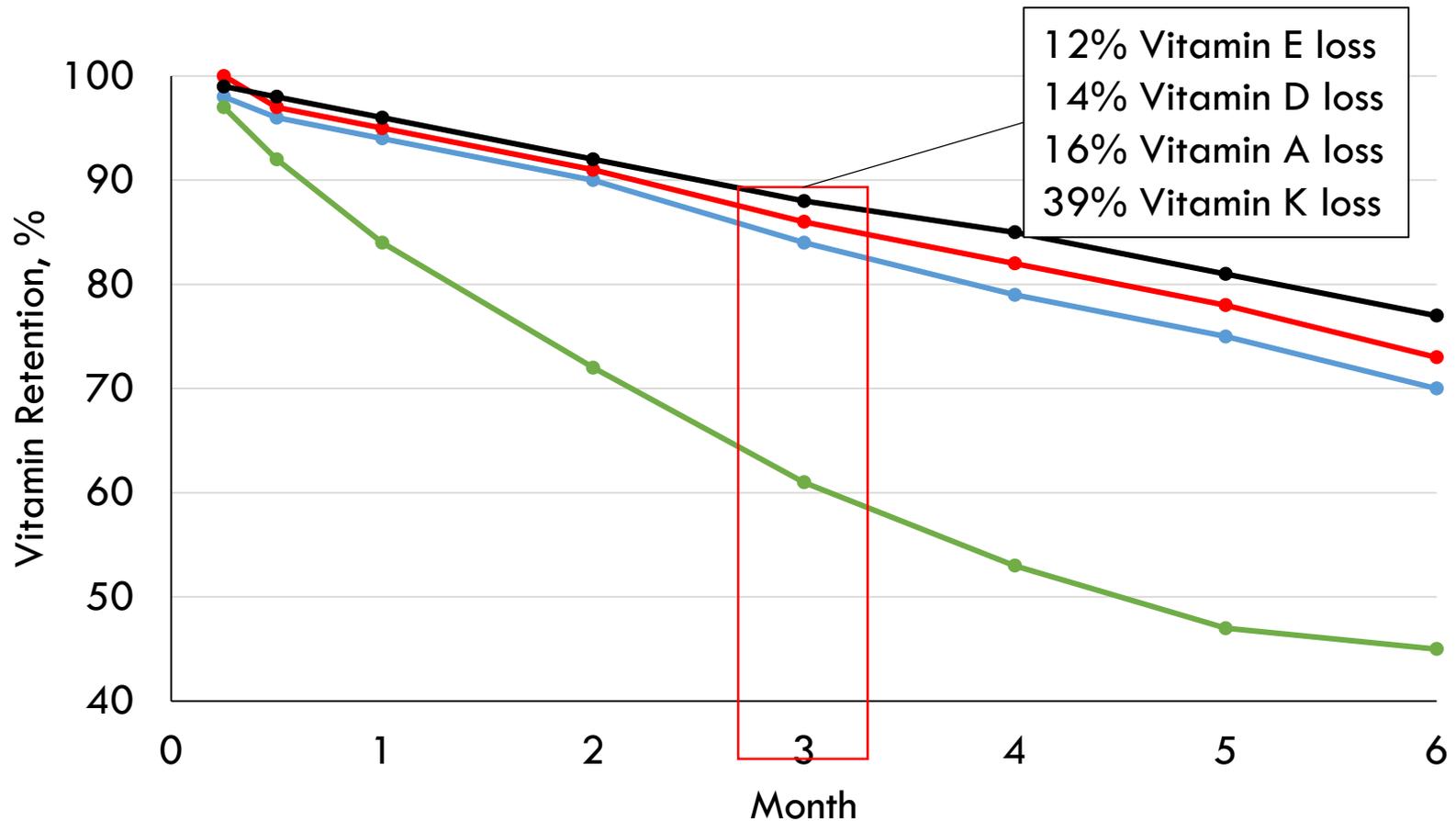


# Vitamin Retention in Vitamin Only Premix



—●— Vitamin A (beadlet, cross-linked) —●— Vitamin D (beadlet, cross-linked)  
—●— Vitamin E (acetate 50%) —●— Vitamin K (MNB)

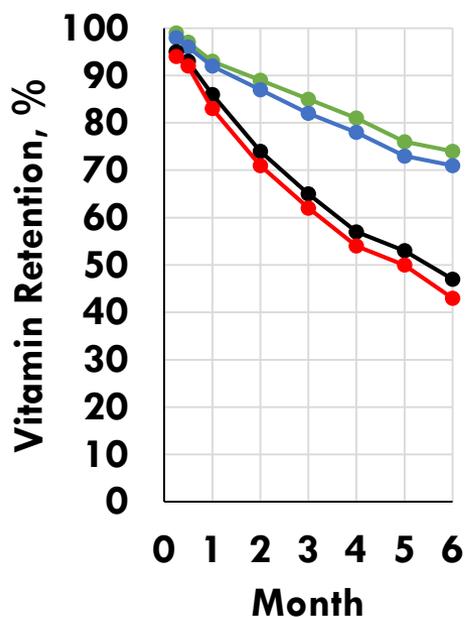
# Vitamin Retention in VTM Premix



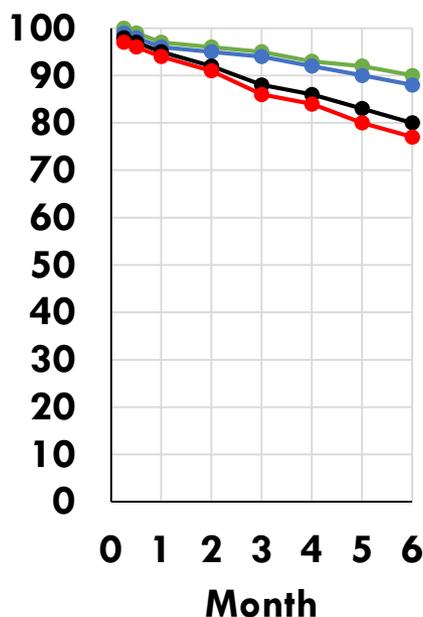
—●— Vitamin A (beadlet, cross-linked) —●— Vitamin D (beadlet, cross-linked)  
—●— Vitamin E (acetate 50%) —●— Vitamin K (MNB)

# Mineral Source Affects Vitamin Stability in Premixes

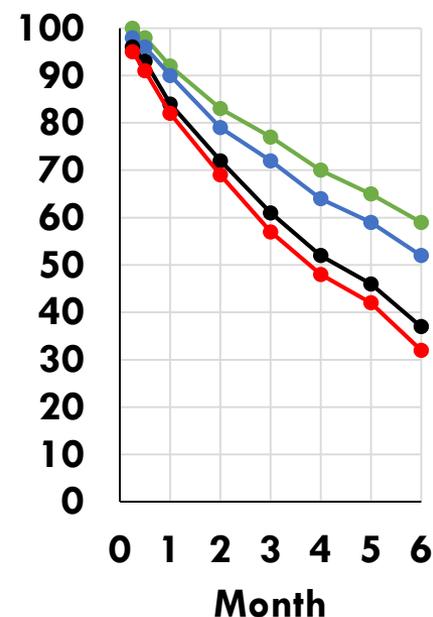
## Vitamin A (beadlet)



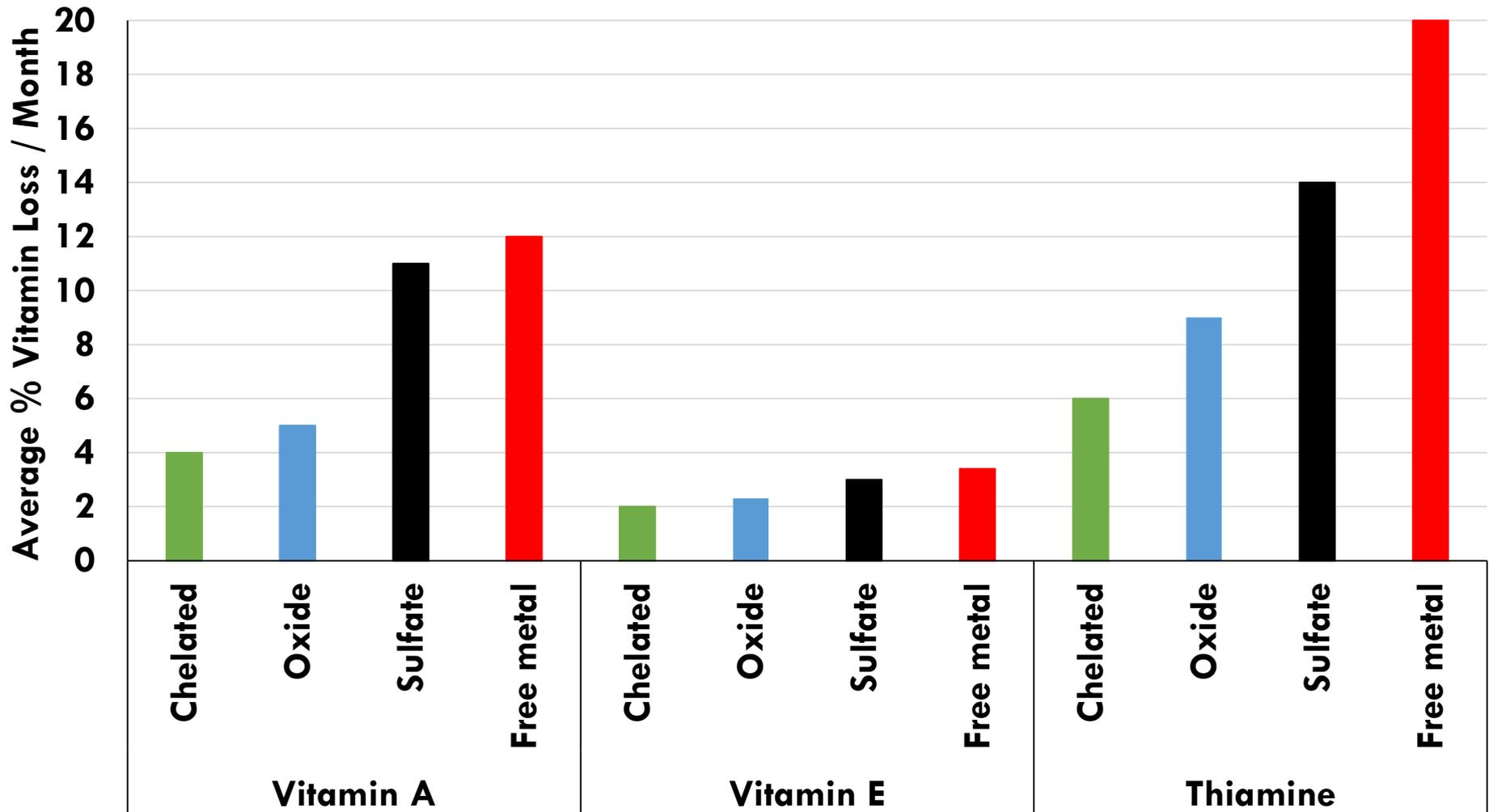
## Vitamin E (acetate 50%)



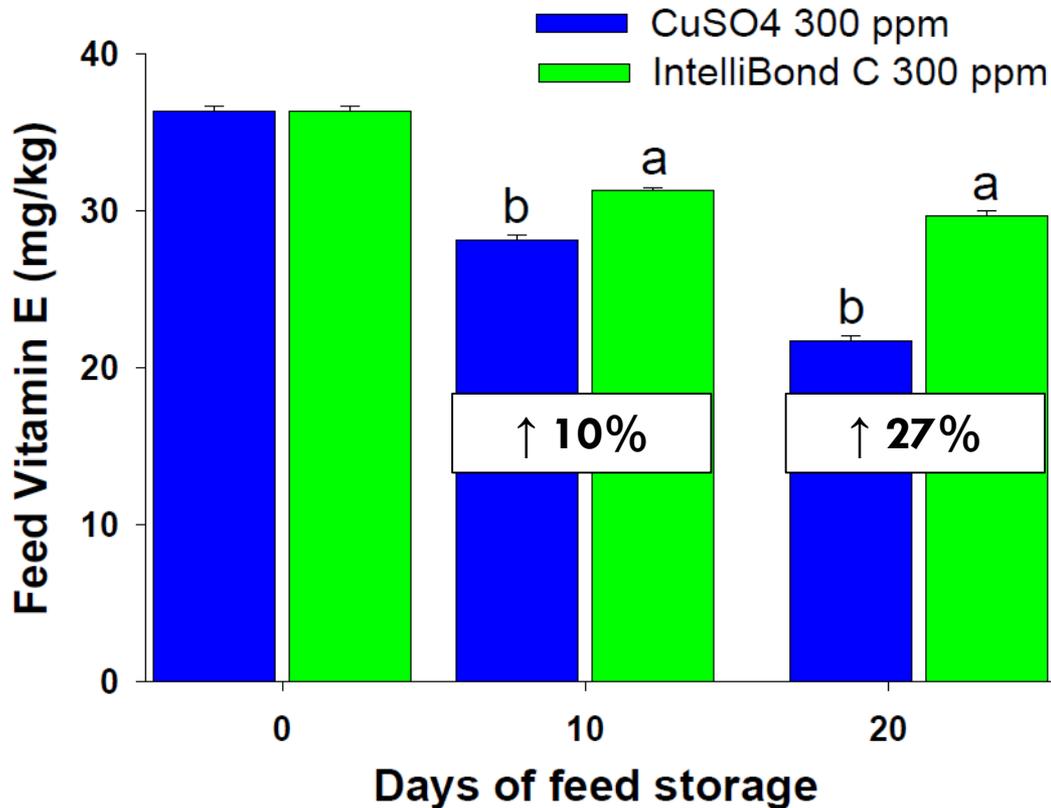
## Thiamin (Mononitrate)



—●— Chelated —●— Oxide —●— Sulfate —●— Free Metal

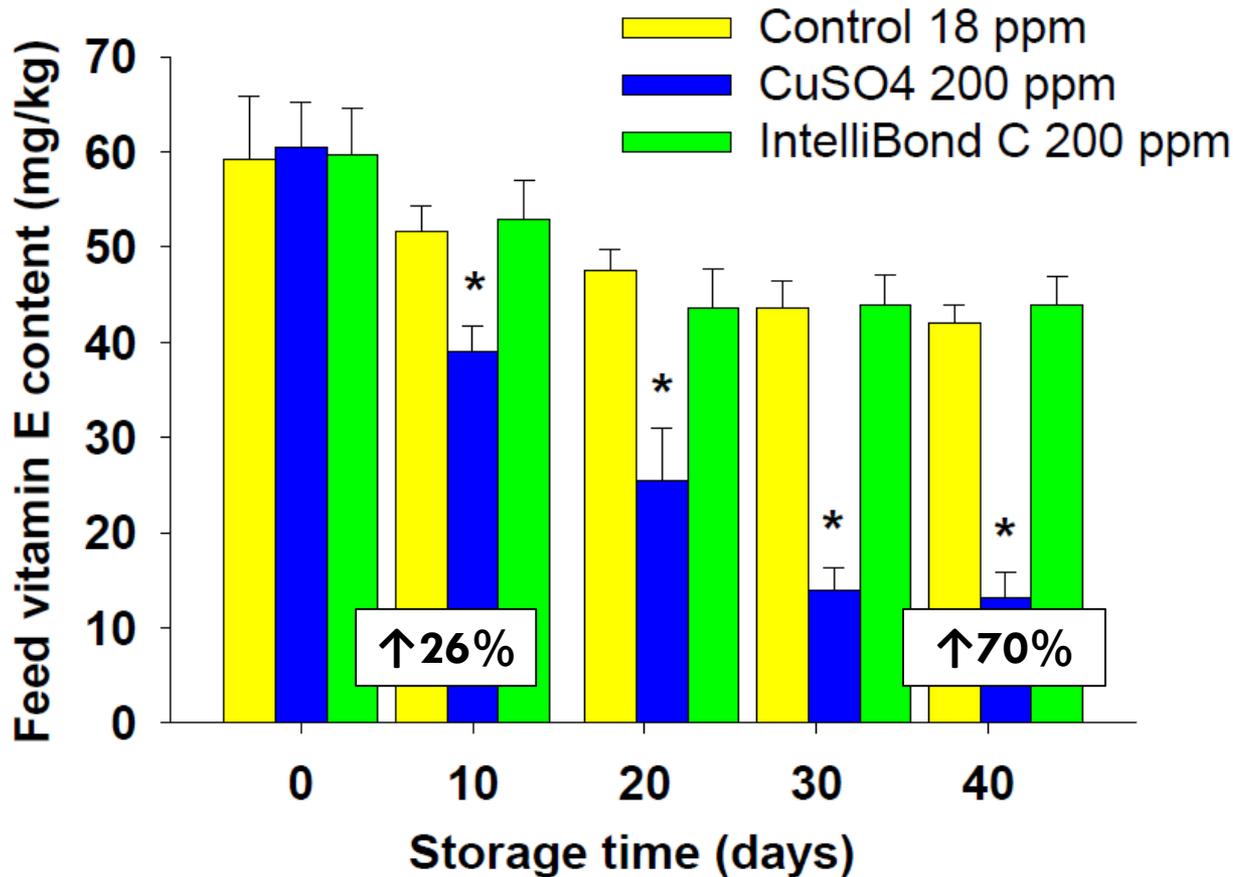


# Vitamin E Stability with Copper Sources



- Broiler mash diets contained all-rac- $\alpha$ -tocopheryl acetate.
- Diets were stored at room temperature.
- Hydroxy Cu diets retain more vitamin E than those with  $\text{CuSO}_4$ .
- Feed levels corresponded to 5% higher liver vitamin E in 21 d Hydroxy Cu-fed chicks ( $P < 0.05$ ).

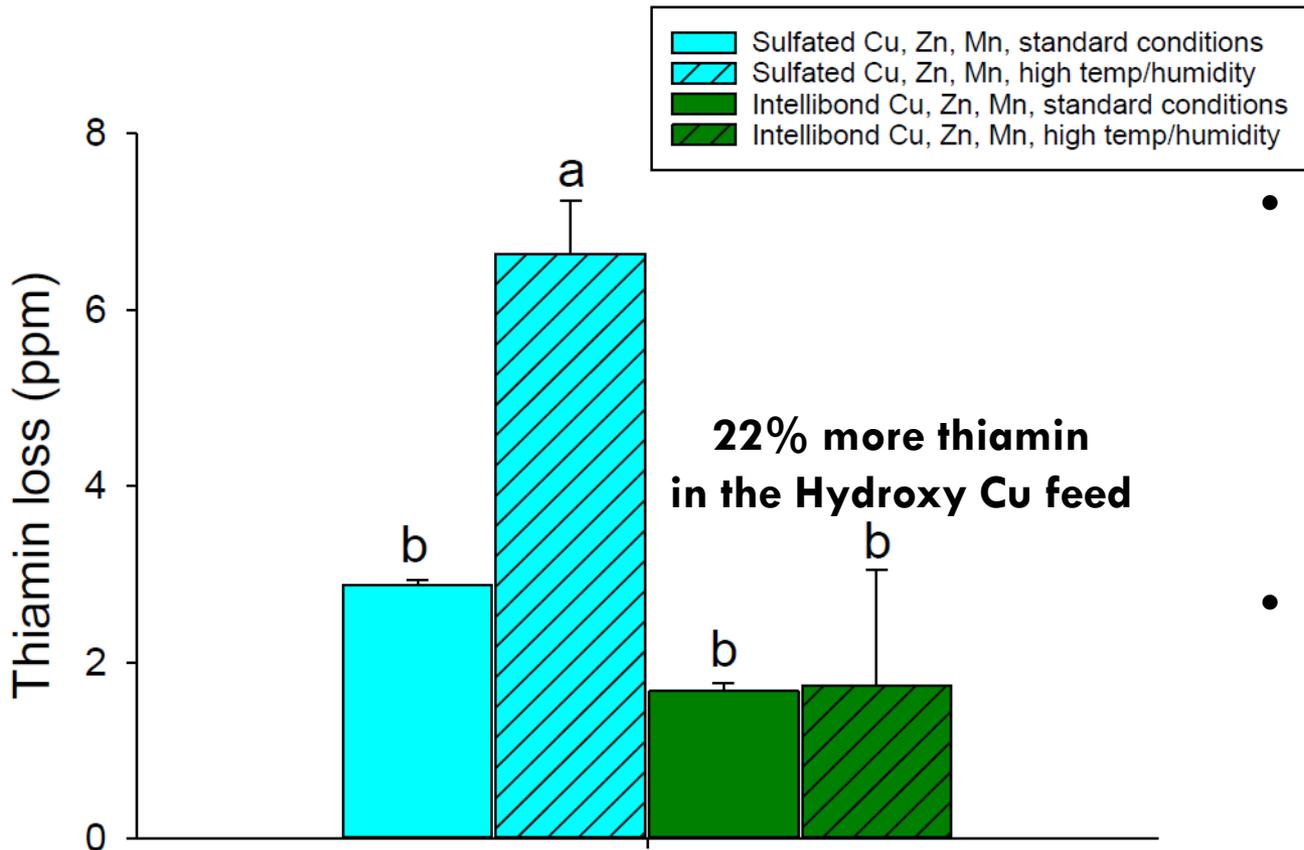
# Vitamin E Stability with Copper Sources



- Broiler mash diets contained all-rac- $\alpha$ -tocopheryl acetate.
- Diets were stored at 18°C (64°F).
- Hydroxy Cu diets retain more vitamin E than those with CuSO<sub>4</sub>.
- Feed levels corresponded to higher liver and plasma vitamin E in Hydroxy Cu--fed chicks vs. CuSO<sub>4</sub> (P<0.05).

\* Within a time point, mean is significantly different from Control (p<0.05).

# Thiamin Stability with Hydroxy TMs



- **Extruded fish diets containing:**
  - 20 ppm Cu
  - 200 ppm Zn
  - 100 ppm Mn
  - 25 ppm thiamin
  - 11% added fish oil
- **Standard warehouse conditions versus high temperature and humidity (37°C/75% RH) for 60 days**



**August**



**September**



**October**



**November**



Courtesy: Bing





Courtesy: Dr. Trey Patterson





Courtesy: Bing





Courtesy: Bing



# Summary

- **Vitamins are essential but are also stored in the body (animal has reserves...3-6 months)**
- **Quality Forages contain mostly adequate amounts of Vitamin A (Vitamin E SHOULD be similar)**
- **Vitamins are sensitive to water, heat and light (Supplemental Feed and Feed Manufacturing)**
- **Storage time of finished feed products can be harmful to vitamins**
- **Sulfate Sources of trace minerals can be harmful to vitamins**
- **Was it the actual nutrient (vitamin)...or the delivery of the nutrient (minerals/manufacturing)?**
- **Ask**



# Questions

**Jeff Heldt**  
**Jeff.heldt@micro.net**

