



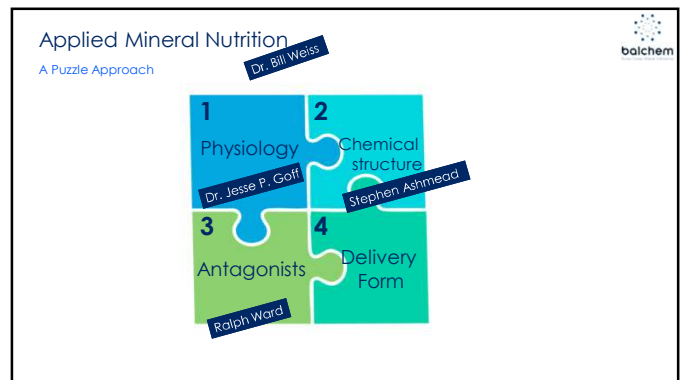
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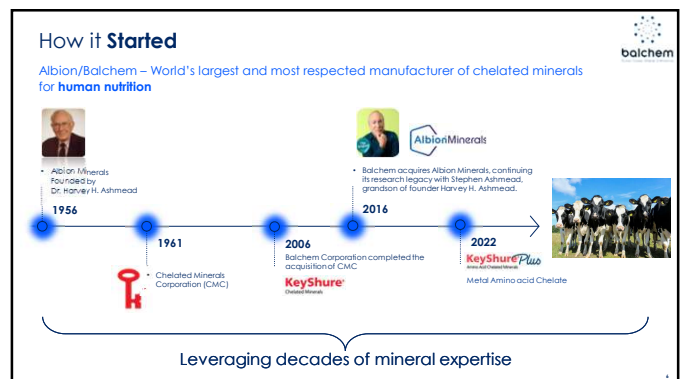
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Macro Mineral	Main absorption organ
Calcium (Ca)	Small intestine (duodenum, jejunum)
Phosphorus (P)	Small intestine (jejunum)
Magnesium (Mg)	Rumen-reticulum
Sodium (Na)	Small intestine
Potassium (K)	Rumen

Micro Mineral	Main absorption organ	Key limitation
Iron (Fe)	Duodenum	Low absorption; antagonized by Ca, Cu
Manganese (Mn)	Small intestine	Very low inherent absorption
Zinc (Zn)	Small intestine	Antagonized by Cu, Fe, phytates
Copper (Cu)	Small intestine	Strongly antagonized by Mo + S
Cobalt (Co)	Rumen (B12 synthesis)	B12 absorbed in ileum
Selenium (Se)	Small intestine	Chemical form dependent
Iodine (I)	Small intestine	Highly soluble

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rumen solubility

Chelated VS Complex

Single amino acid-metal chelate

Bis-amino acid metal chelate

Zinc glycinate-chloride complex

COMPLEX
Zinc Methionine

PubChem

Vitamin recovery in premixes containing inorganic and Balchem chelated minerals
90 days, at 68°F

Total amount of ZINC transported across the cell membrane of the Caco-2 cell line

Slide 10

JS1 "True Chelated"" is not an accepted mineral category by the FDA.
There's just Chelated.

Jason Schmidt, 2026-02-19T23:32:53.893

MS1 0 Changed for chelated

Maria Spindola, 2026-02-20T01:12:29.769

3. Antagonists

Minimum interaction with antagonists and antinutritional factors

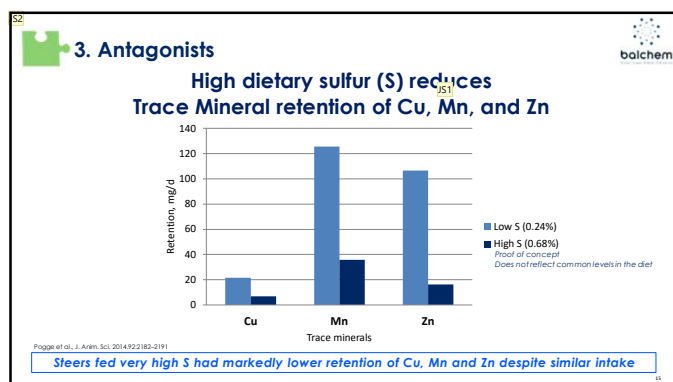


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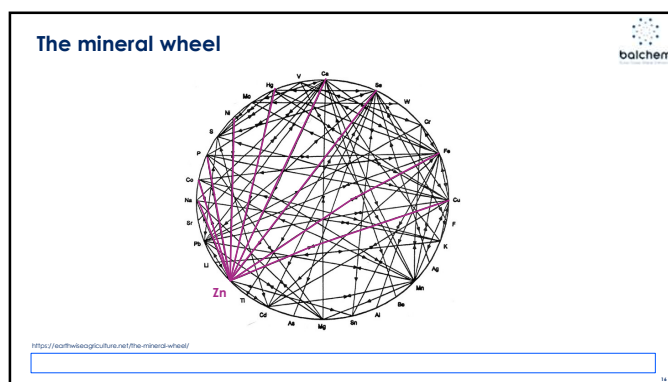
What are antagonists in our world?



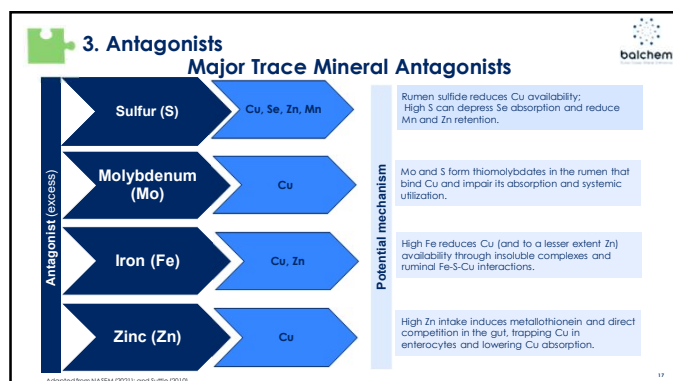
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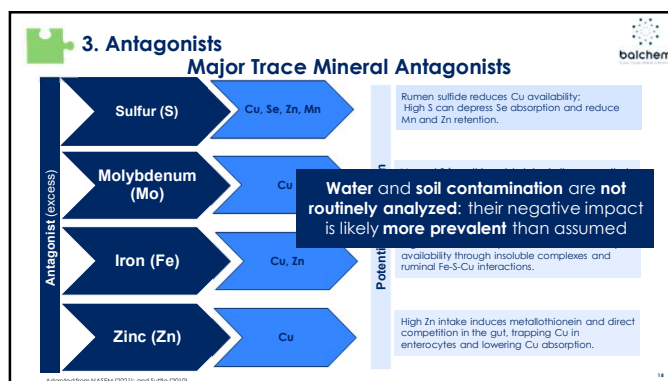
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Slide 15

JS1 Clean Coal technologies have lead to a 95--99% reduction in SO2 emmissions and soil S levels. Over the past 5 years, has there been a large number of complaints of grain and forage analysis returning high S levels?

Jason Schmidt, 2026-02-19T23:20:33.153

MS1 0 I removed the picture with high probability levels of sulfur and can add that : Clean air regulations have reduced atmospheric sulfur deposition over time, however, in modern production systems, today dietary sulfur can still exceed antagonist thresholds due to DDGS inclusion, water and certain forages

Maria Spindola, 2026-02-20T01:09:38.574

JS2 This N number appears quite low, at least to a former poultry and swine researcher.

Jason Schmidt, 2026-02-19T23:21:57.188

MS2 0 From monogastric perspective , I agree. But for ruminants, it's understandable ..!

Maria Spindola, 2026-02-20T01:07:44.070

3. Antagonists

Regional Exposure to trace mineral antagonists

West / High Plains
High sulfate water and alkaline, irrigated soils:
S and Mo exposure

Northeast / Mid Atlantic
Sludge ash contamination
and Water Fe

Corn Belt / Upper Midwest
High coproduct usage:
dietary sulfur variability

Southeast
Acidic soils → low Mo;
antagonism is diet-driven

Regional differences in exposure to TM antagonists could be substantial and should be considered when formulating mineral programs

NASEM (2021); Kabata-Pendias (2011); Drewnoski et al. (2014)

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4. Delivery Form

Direct benefits of higher concentration

	A	KeyShure ^{Plus}
Zn	12%	20%
Mn	8%	18%
Cu	10%	20%
Fe	10%	18%
g/ cow/ day	16.9	8.8
Truckload	1.9	1

Considering NASEM 2021 Mineral recommendation

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4. Delivery Form

Excellent physical characteristics

- High Flowability
- Less Dust
- Less Loss !!!**
- Safer to handle

KeyShure^{Plus}
Amino Acid Chelated Minerals

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Applied Mineral Nutrition

A Puzzle Approach

KeyShure^{Plus}
Amino Acid Chelated Minerals

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More Bioavailability^{US1}, Maximum Results

More bioavailable mineral at the cellular level – maximizing absorption, minimizing antagonisms and converting nutrition into performance

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1 Proven performance results

Cows fed with **KeyShure Zn, Mn, and Cu** had

- higher colostrum immunoglobulin levels
- lower calf mortality at calving.

	Primiparous			Multiparous		
	Inorganic	KeyShure	P-value	Inorganic	KeyShure	P-value
Calf mortality at calving	9.6%	5.1%	0.58	15.6%	5.6%	0.05

Lactation performance 0-150 days

Parameter	Inorganic	KeyShure	P-value
Milk, lbs/d	79.6	78.7	0.802
Milk Fat, %	3.86	4.03	0.033
Milk Crude protein, %	3.21	3.23	0.381

Farrington et al. 2013

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Slide 23

JS1 I understand this is a 'tag line' but I have a real problem with the implications here. What about the law of diminishing returns? This explicitly states that feeding 40% zinc in a diet will give you more milk or beef than feeding 20% Zinc. Call me Mr. Practical or something else when this just doesn't ring true.

Jason Schmidt, 2026-02-19T23:36:29.401

MS1 0 I understand your point. This is the name of the lecture actually....I can change in the presentation, adding a * saying that we don't recommend using more mineral , instead using more bioavailable sources. What do you think about the below sentence

Maria Spindola, 2026-02-20T01:15:25.806

2 Bioavailability - Independent study
University of Florida

balchem

Estimated relative bioavailability (RBV) of Zn sources based on biomarkers

Species / Biomarker	Zn Sulfate	Zn Amino Acid	Zn Methionine	KeyShure Zinc
Broiler (Bone)	100%	96%		130%
Broiler (Mucosa)	100%	81%		109%
Lamb (liver metallothionein)	100%	111%	116%	131%

Cao et al. 2000

Confidential

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How to choose the best source of chelated mineral?

balchem

- ✓ Proprietary Chelation Technology
- ✓ Fewer nutrient interactions
- ✓ Superior Bioavailability
- ✓ Proven performance results
- ✓ Highest concentration
- ✓ Excellent physical characteristics

KeyShure[®] Plus
Amino Acid Chelated Minerals

Maria.Spindola@balchem.com

KeyShure minerals: check all the boxes

Confidential

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