Optimizing Premix Quality, Homogeneity and Stability

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What Makes A Good Premix?

Micronutrients are typically used at levels less than 200 g/T of feed.
A premix is a homogenous blend of low inclusion micro ingredients distributed throughout a carrier
Micronutrients are typically used at levels less than 200 grams/tonne feed.
Considerations:

- Product form for optimal vitamin stability
- Good flowability and mixability characteristics
- Consistent particle size for homogenous premix
- Adequate amount of organic carrier (min. 30% ideally)
- Maximum moisture content of 12%
- pH range of 4 to 6 (for vitamin stability)
- Dust suppressant at 0.5 to 2 %

Micronutrients in a Typical Broiler Feed (Approximate Levels per Tonne of Feed)	
Micronutrient / Product	Amount (grams)
ROVIMIX A 1000	12
ROVIMIX D3 500	8
ROVIMIX E 50	100
MSBC	9
ROVIMIX B1	3.3
ROVIMIX B2 80	10
ROVIMIX NIACIN	60
ROVIMIX B6	3.6
ROVIMIX CALPAN	16.6
ROVIMIX FOLIC 80	0.1
ROVIMIX BIOTIN	12.5
ROVIMIX B12 1%	2.5
Subtotal (Vitamins)	**243**
CALCIUM IODATE	10
COPPER SULFATE	60
FERROUS SULFATE	125
MANGANESE OXIDE	200
ZINC OXIDE	167
MICROGRAN SE 4.5%	6.7
Subtotal (Minerals)	**569**
Total Micronutrients	**812**

Biotin

Critical Issues

- Particle counts/gm
- Accurate dispersion

Feed intake	Animal	# of active d-biotin particles consumed per day
Weight: 8 kg Daily feed intake: 0.3 kg (0.25 mg/kg feed)		Triturate: 2625 particles Rx Biotin: 112,500 particles Rx Biotin HP: 30,000 particles
Weight: 30 g Daily feed intake: 7 g (0.15 mg/kg feed)		Triturate: 37 particles Rx Biotin: 1575 particles Rx Biotin HP: 420 particles
Weight: 100 mg Daily feed intake: 10 mg (0.20 mg/kg feed)		Triturate: 0.07 particles Rx Biotin: 3 particles Rx Biotin HP: 0.8 particles
Weight: 650 kg Daily feed intake: 25 kg (0.80 mg/kg feed)		Triturate: 700,000 particles RX Biotin: 30 mio particles Rx Biotin HP: 8 mio particles

Amount of biotin consumed by a sow in a year

Rovimix Biotin is specially formulated for use in feed applications to ensure complete dispersion throughout feed.

Low inclusion of biotin in feed = need for high active particle count (mixability)

Biotin: Dilution versus Spray Dried

Biotin Crystal - Whole

Biotin Crystal - Crushed

Dilution on Carrier

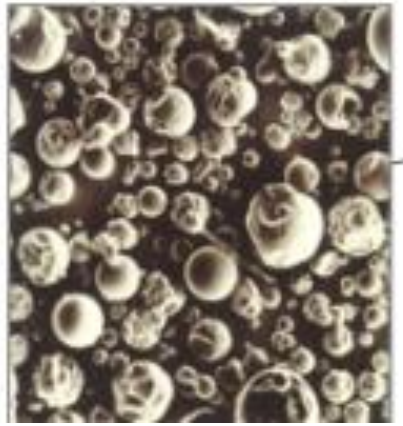
10% of particles contain Biotin.

1 million d-biotin particles per gram

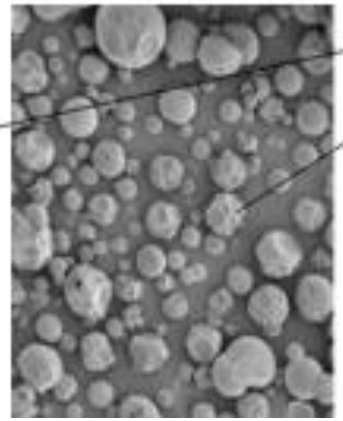
Not water soluble.

Spray Drying

Rovimix Biotin (2%)



Rovimix Biotin HP (10%)



Each individual particle contains 2% or 10% Biotin, respectively.

20 million d-biotin particles per gram.

Water soluble.

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Active substance sensitivity

Figure 1 - External factors influencing stability of non-formulated feed additives

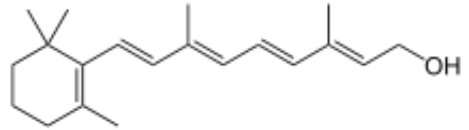
Additive	Temperature	Oxygen	Humidity	Light
Vitamin A	++	++	+	++
Vitamin D	+	++	+	+
25-OH-D3 (Calcifediol)	++	++	+	+
Vitamin E	0	+	0	+
Vitamin K3	+	+	++	0
Vitamin B1	+	+	+	0
Vitamin B2	0	0	+	+
Vitamin B6	++	0	+	+
Vitamin B12	++	+	+	+
Pantothenic acid	+	0	+	0
Nicotinates	0	0	0	0
Biotin	+	0	0	0
Folic acid	++	0	+	++
Vitamin C	++	++	++	0
Carotenoids	++	++	+	++
Enzymes	++	++	+	++
Enterococcus faecium	++	0	++	+
Essential oils	++	++	+	++
Benzoic acid	0	0	0	0

++ Marked effect

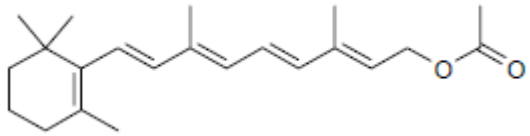
\+ Moderate effect

o No effect

Retinol



Retinyl-acetate



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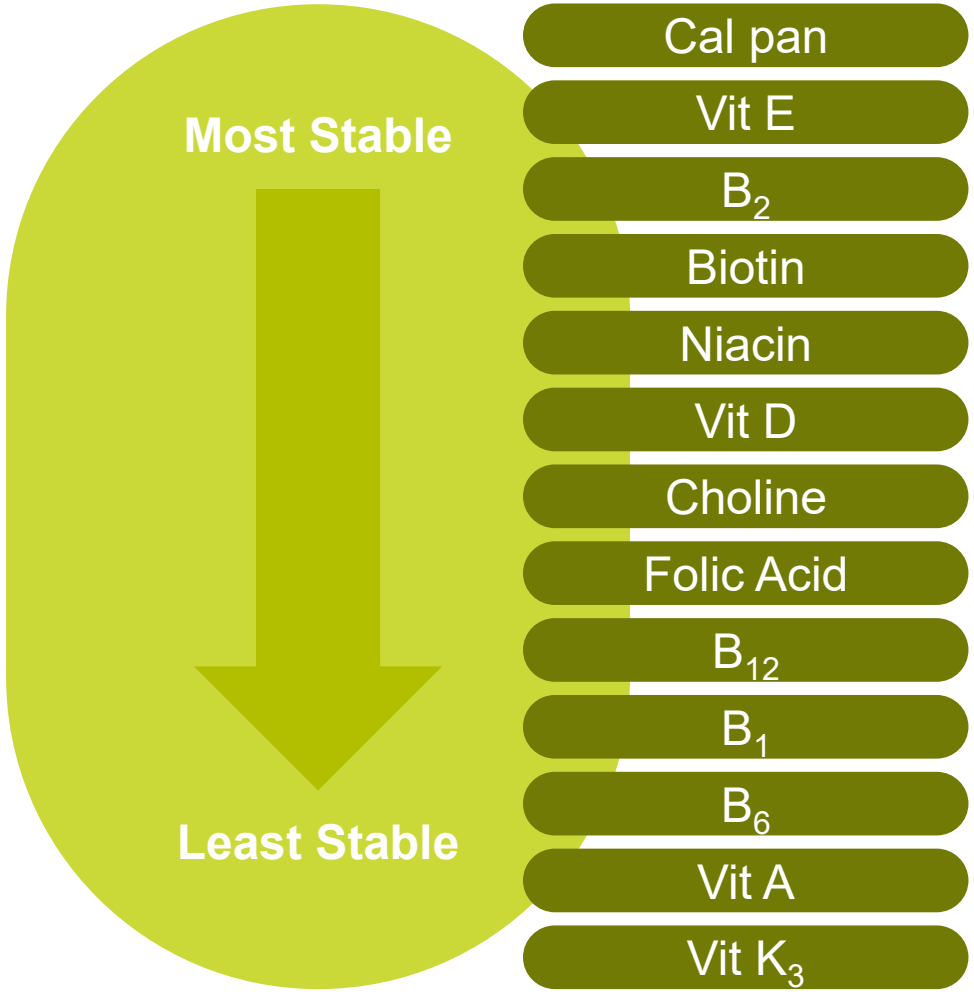
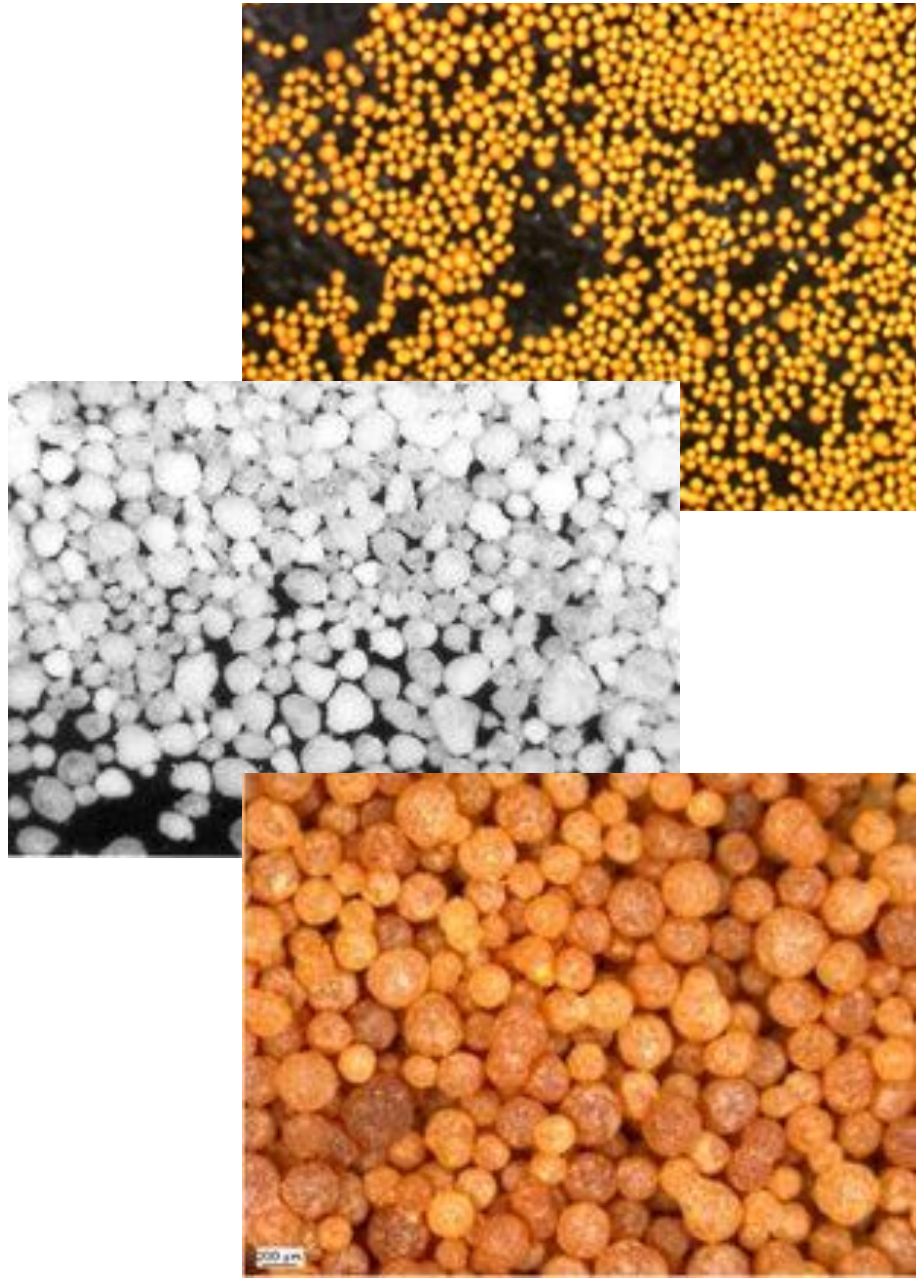
Summary of loss activity rankings

Shurson et al. 1996



Product Forms

Vitamin	Formulation	To Improve
Vitamin A	Spray dry (SD), beadlet with BHT	Stability, solubility
Vitamin D3	Spray dry (SD), beadlet with BHT	Stability, uniform distribution
Vitamin E	SD, adsorbate	Flow, reduced dustiness
Vitamin K/menadione	Crystalline powder	Flow, handling
Thiamine	Coarse granular	Stability
Riboflavin	SD granular	Flow, handling
Pyridoxine	Fine granular crystals	Stability, mixing
Vitamin B12	Crystalline w/carrier	Distribution
Niacin	Crystalline	Flow, reduced dustiness
Niacinamide	Crystalline	Flow, reduced dustiness
Ca-Pantothenate	SD	Flow, reduced dustiness
Biotin	SD	Distribution, handling
Folic Acid	SD	Flow, stability, mixing
Vitamin C	P, ethyl cellulose coat	Stability



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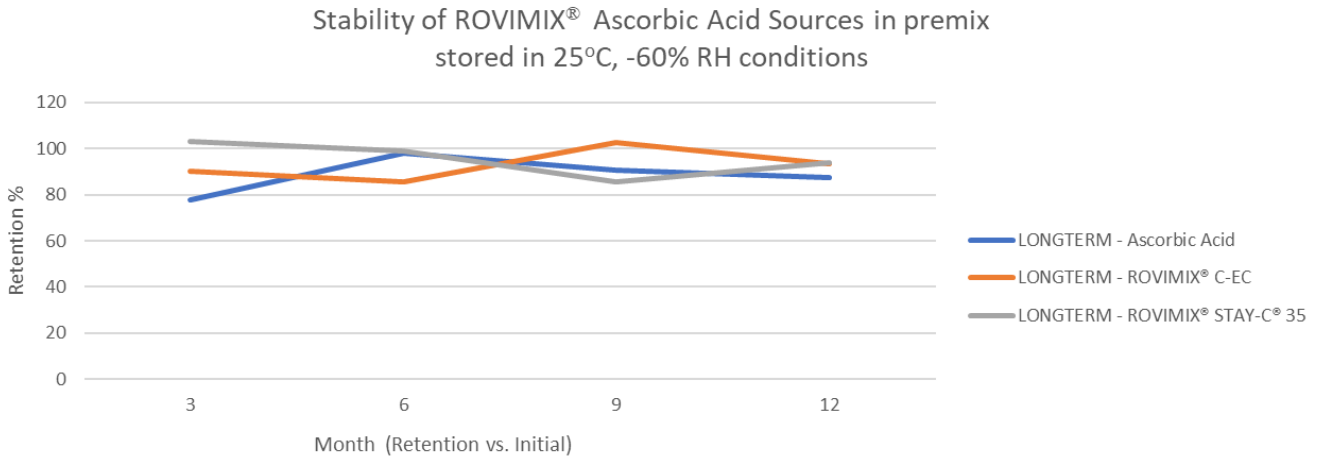
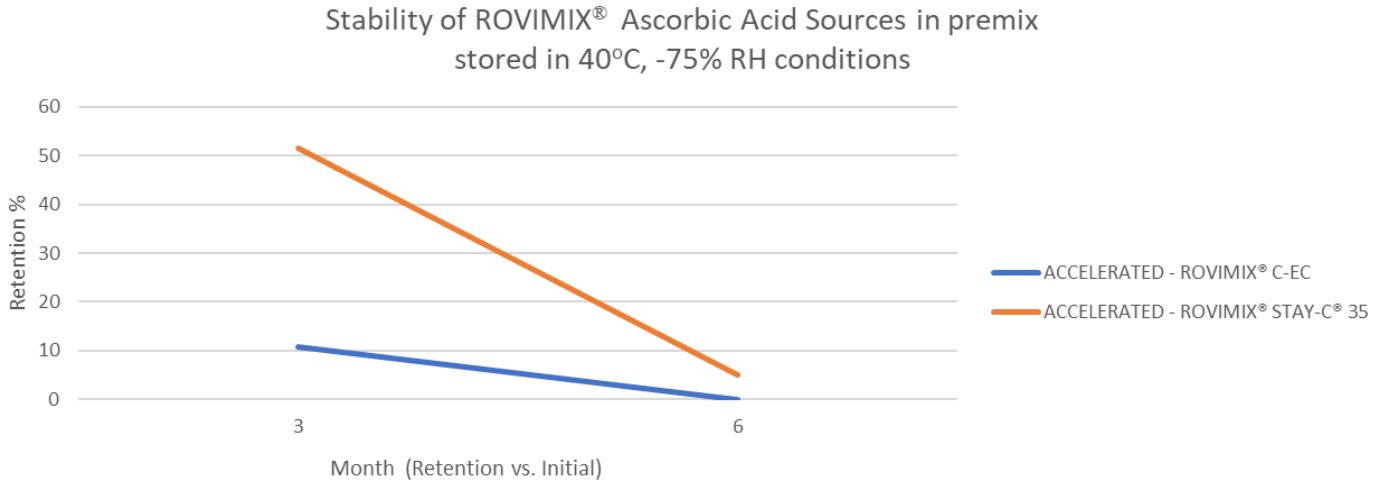
Ascorbic Acid

All ascorbic acid sources show good stability in long-term temperature conditions at 12 months.

Stay-C 35 shows better stability in Accelerated conditions at 3 months.

Ascorbic Acid sources not recommended for Accelerated temperatures over extended period.





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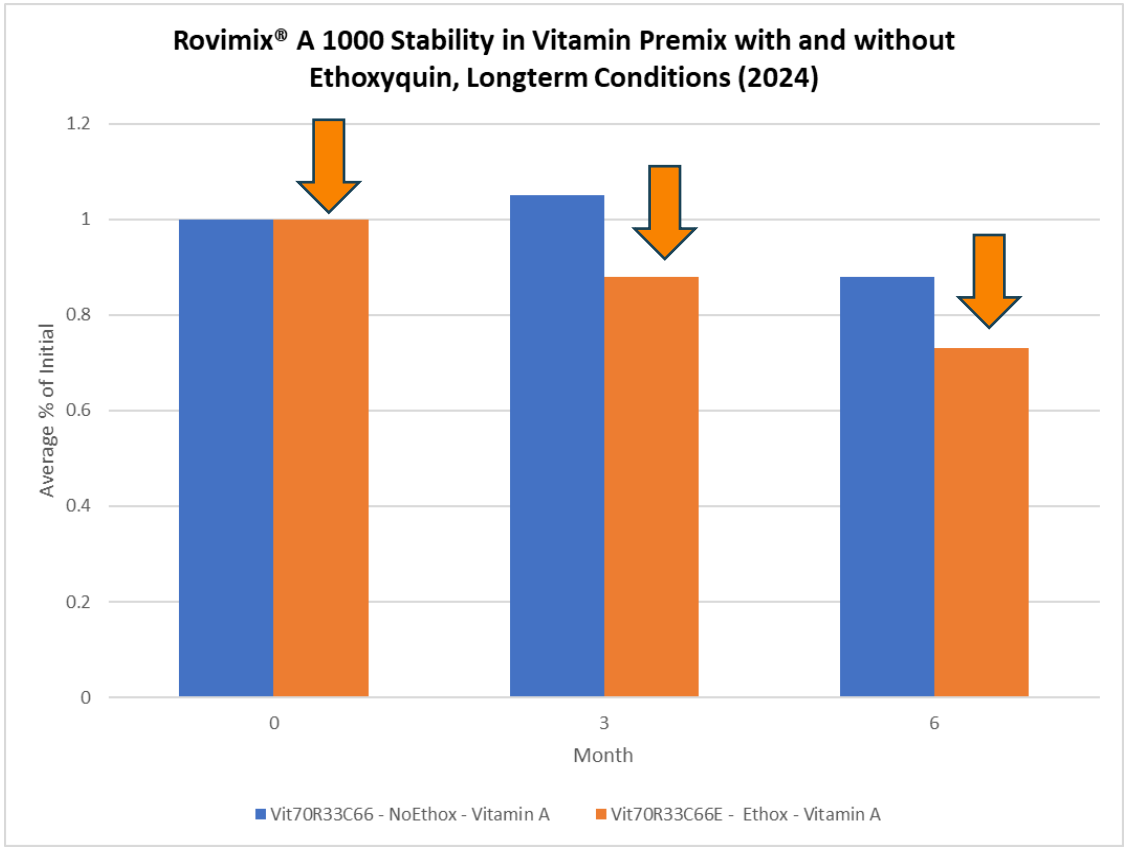
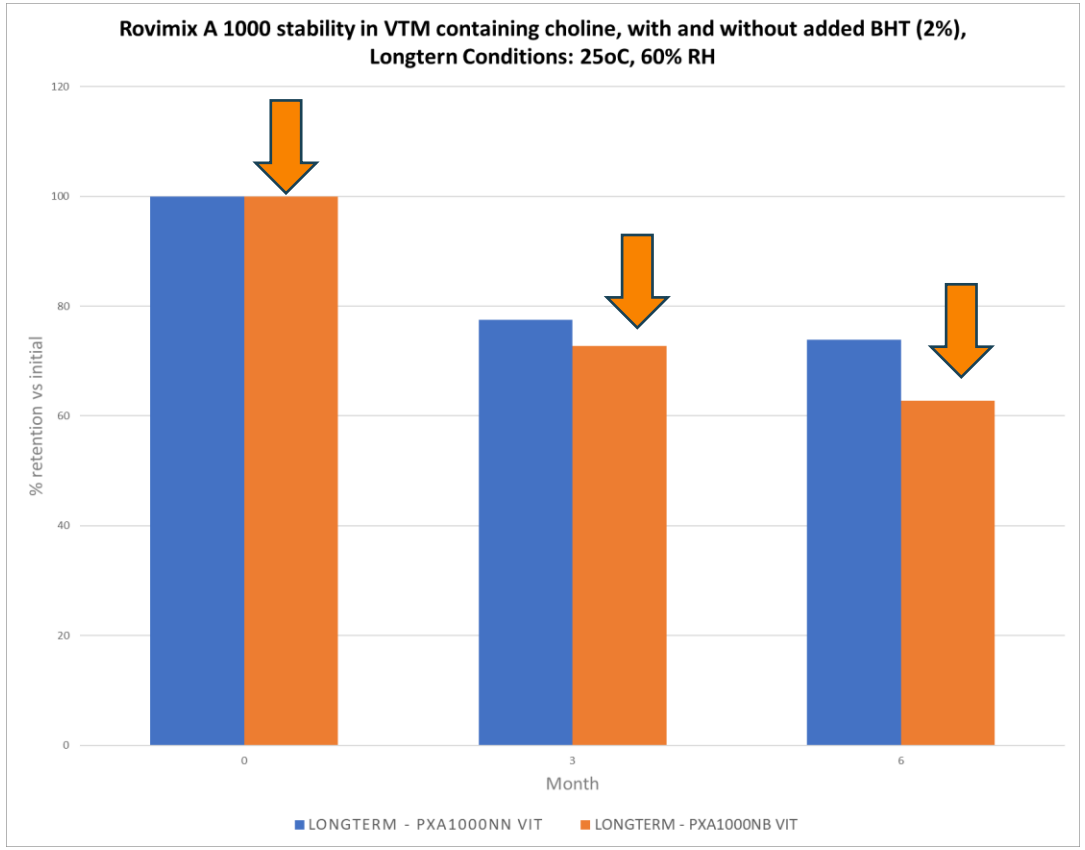
Antioxidants in Premix





Dilute Vitamin premixes of similar nutrient and ingredient composition
Addition of ethoxyquin or BHT to premix (2% inclusion) does not appear to have beneficial effect

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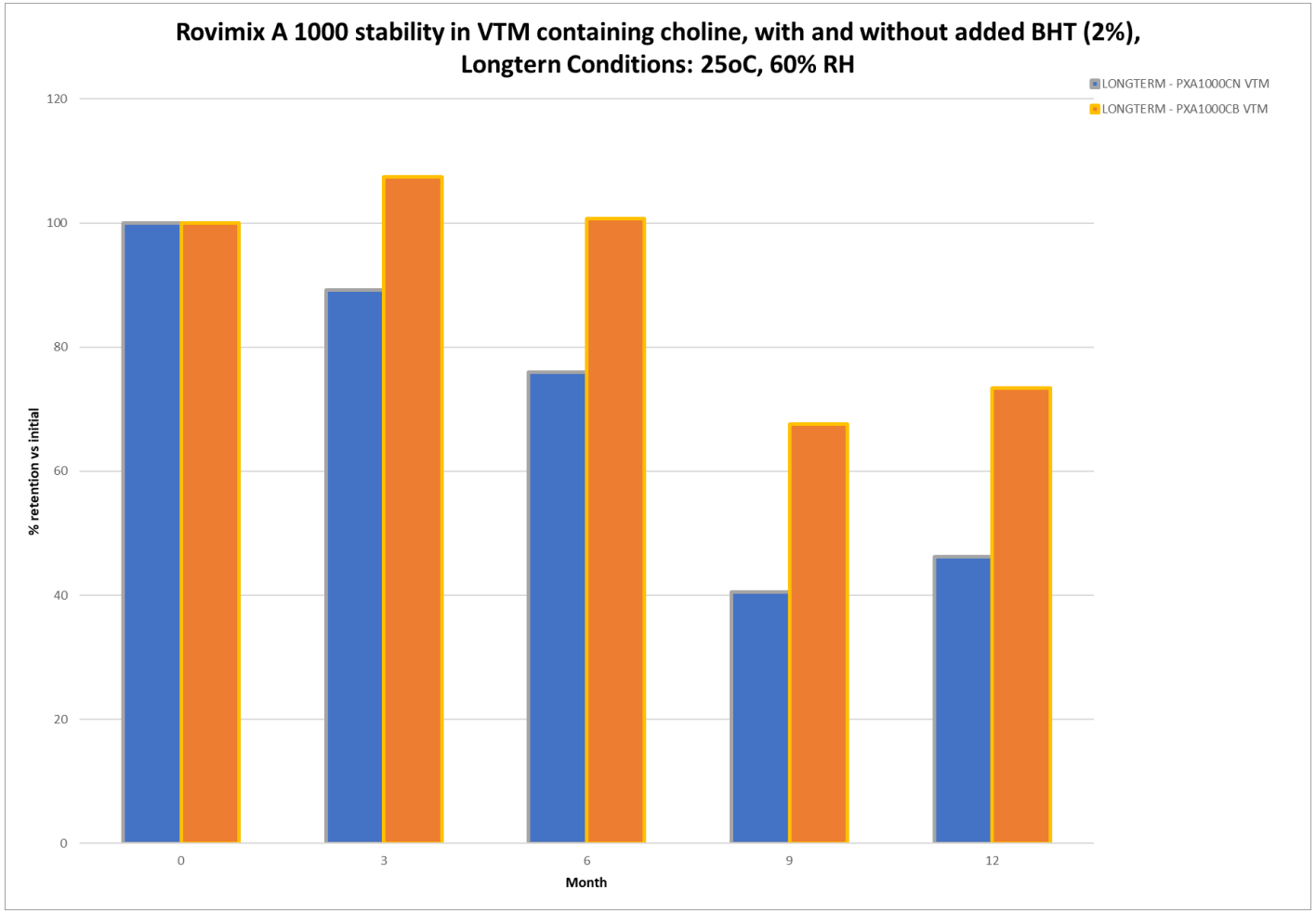
Vitamin A and Choline, with and without BHT

Adding BHT only showed vitamin stability benefit in VTM premix containing choline, vitamin A



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Inclusion of Choline

- Choline with a high (20%) inclusion, once mixed into a vitamin premix in humid conditions, resulted in the entire premix becoming a “cookie dough” consistency.
- Choline can also impact vitamin stability
- Addition of BHT at 2% in stab study showed improved in VTM premix
- Therefore, premix formulations have a maximum 20% choline inclusion.
- Recommend keeping it out of the vitamin premix entirely.

Premix Carriers

- Organic (plant) component acts as a “glue” to maintain a homogenous blend of critical components throughout a premix
- Soft consistency is less abrasive on vitamins

Wheat Middlings

- Particle size comparable to vitamins
- Low dusting

Rice Hulls

- Slightly coarser particle size vs middlings
- More readily available in the US

Wheat Middlings

Rice Hulls

- Most common diluent is calcium carbonate…
- Advantages:
- Inexpensive
- Improves flowability of premix
- Decrease bulk density

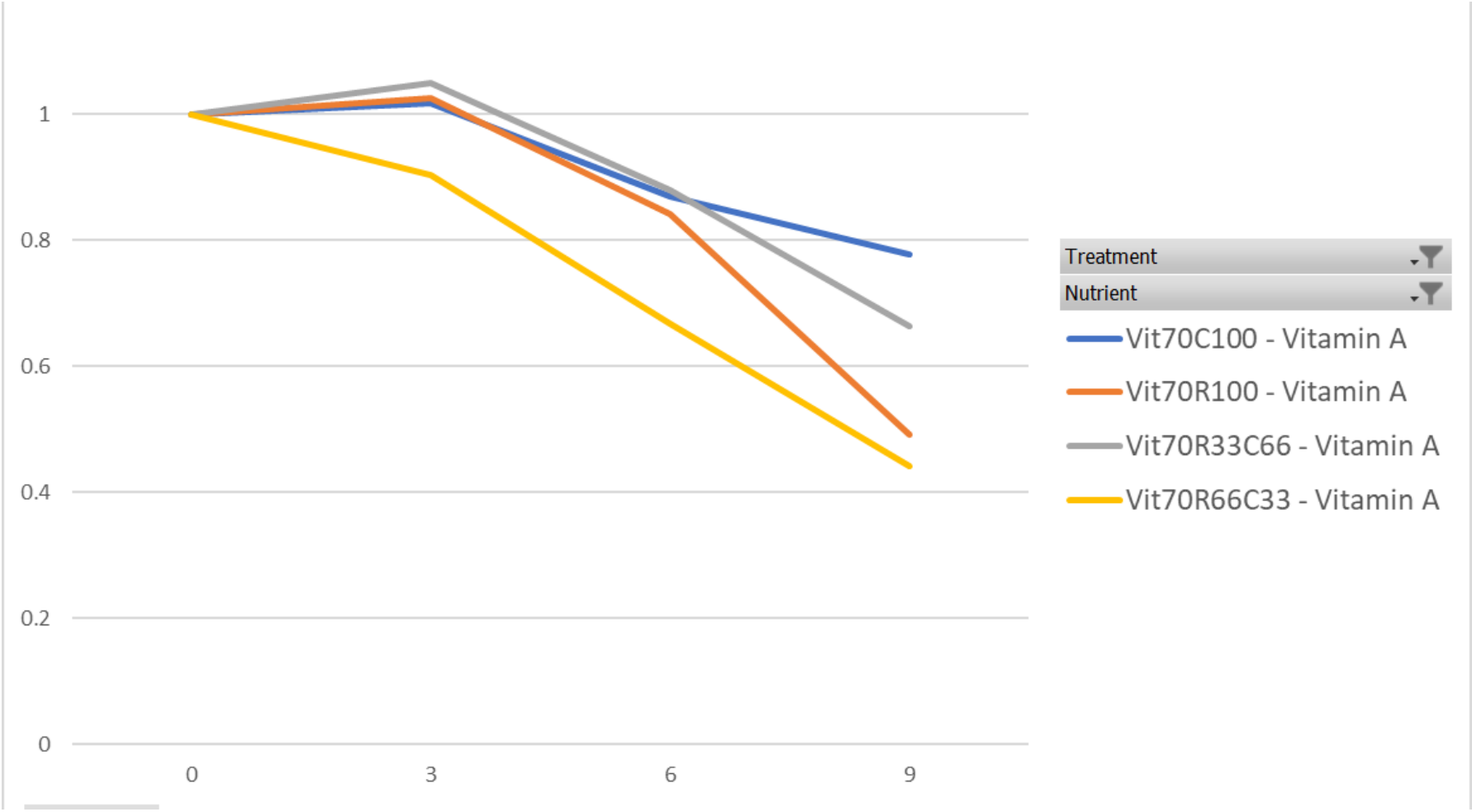
- Disadvantages:
- Segregation and homogeneity issues*
  - *if it’s a high proportion of the blend; depending on the granulation used.
- Dustiness
- Can impact pH of blend

Calcium Carbonate

Impact of Carrier Type and Proportion on Vitamin A

Highest proportion of Carrier (70%)

Faster degradation for the treatments with higher proportions of Rice Hulls with the least concentrated premix.



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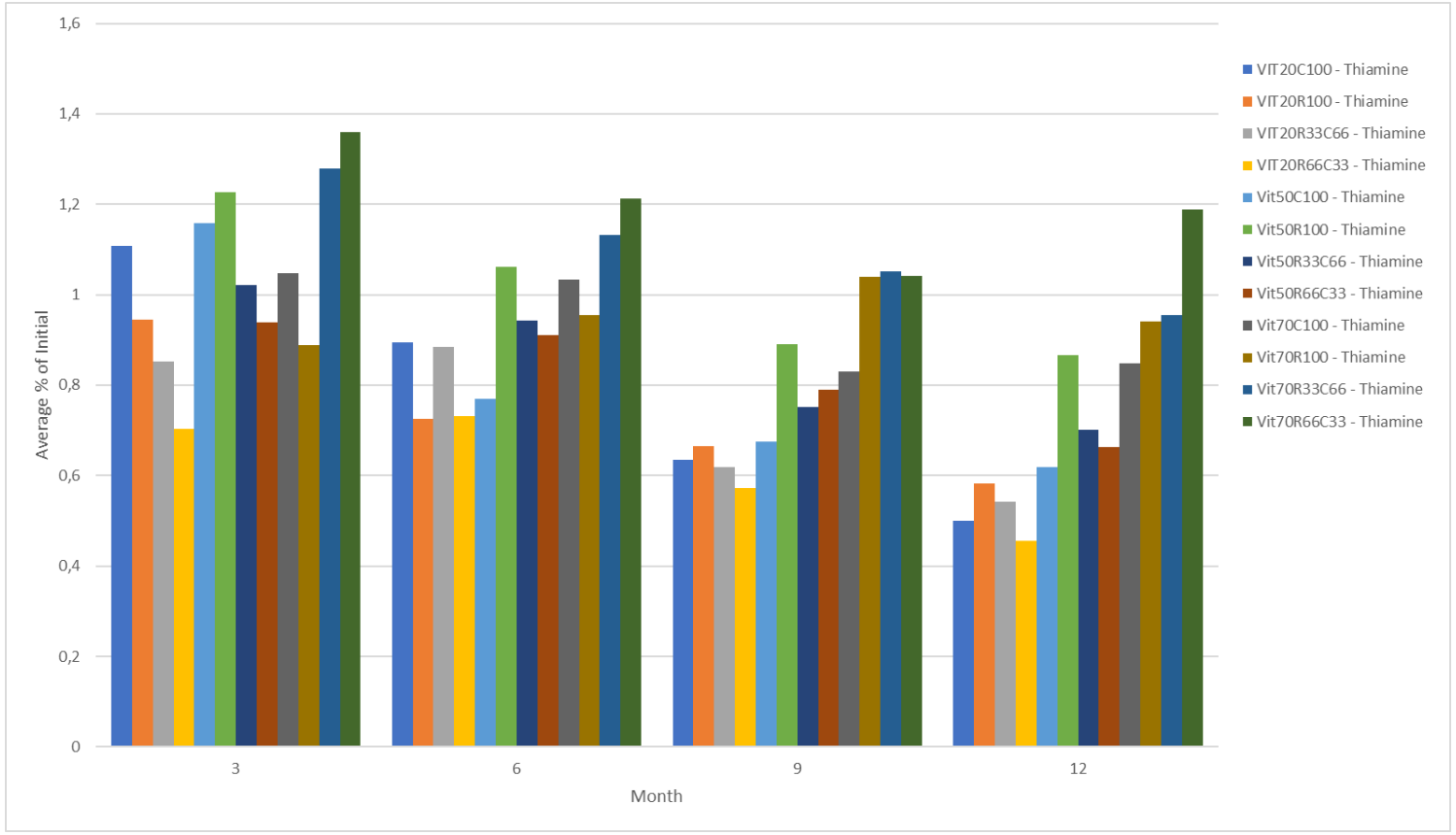
Impact of Carrier Type and Proportion on B-Vitamins

B-vitamins behave opposite to Vitamin A

Increased degradation in concentrated treatments with higher proportions of calcium carbonate.



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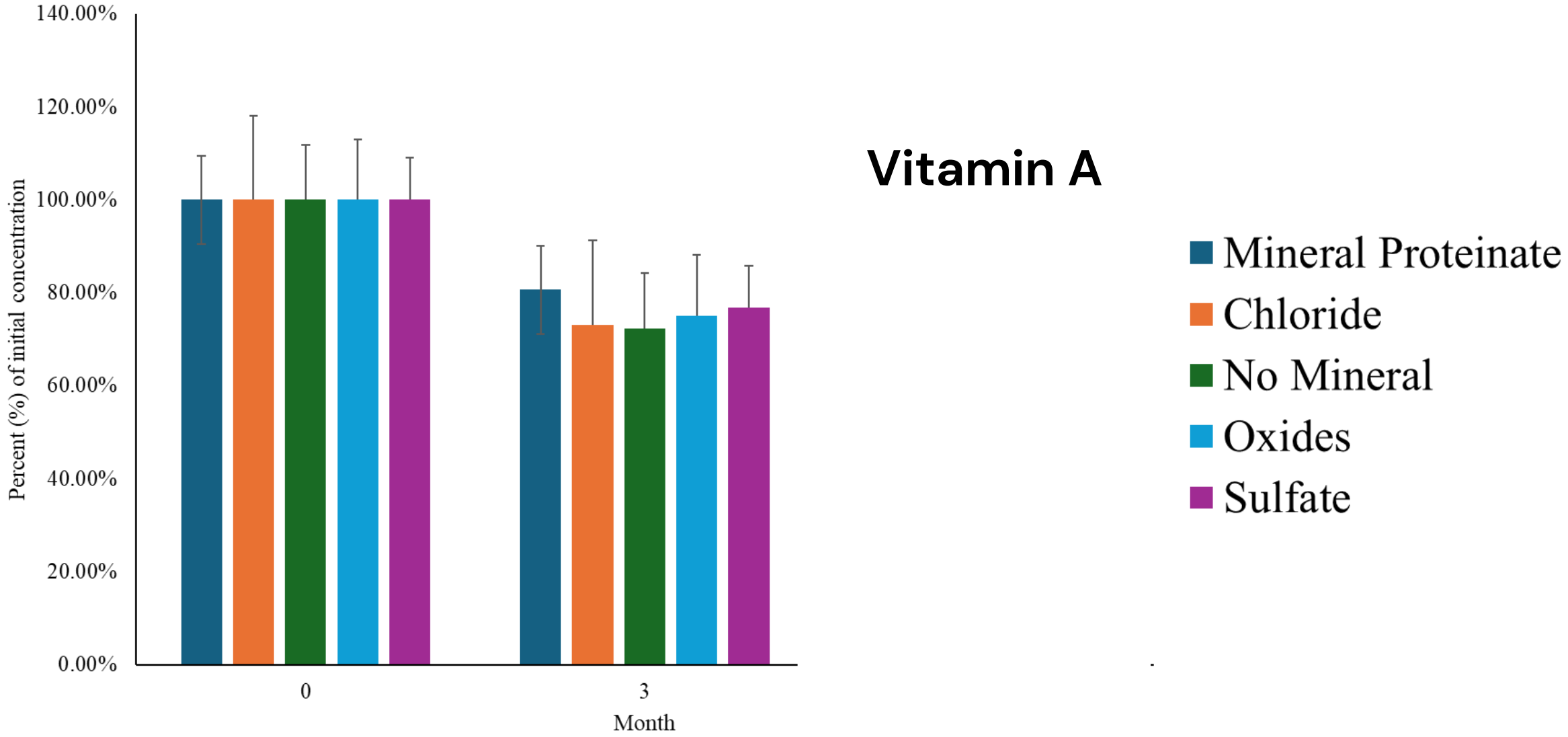
2025 Impact of Mineral Source on Vitamin stability in Premix



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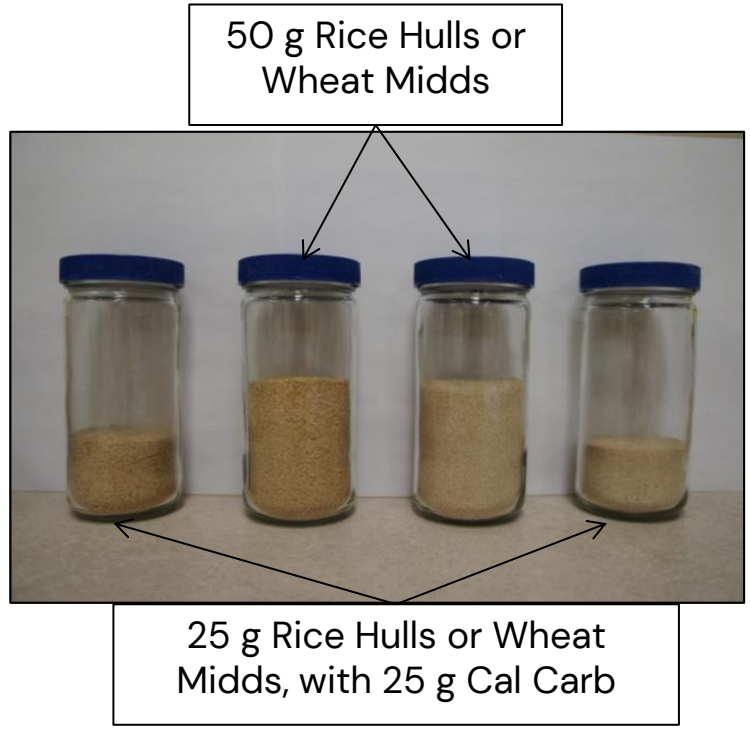
Bulk Density

- Target bulk density in formulation: 0.70 g/mL
- Bulk density of premixes may need to be adjusted due to:
  - Changes in bulk density of carrier (rice hulls/midds)
  - Packaging limitations

Too Dense

Too Bulky

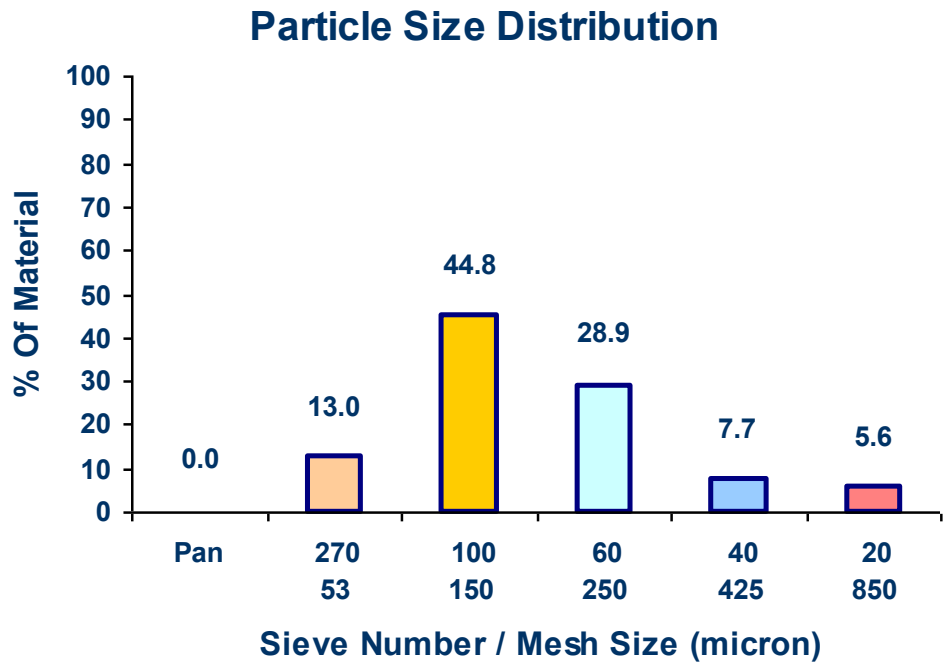


Product	Bulk Density (g/cm^3)
Vitamins	0.52
Wheat Midds	0.4 – 0.6
Rice Hulls	0.36
Ferrous Sulphate	1.3 – 1.4
Zinc Oxide	1.92
Calcium Carbonate	1.61

Particle Size Comparison

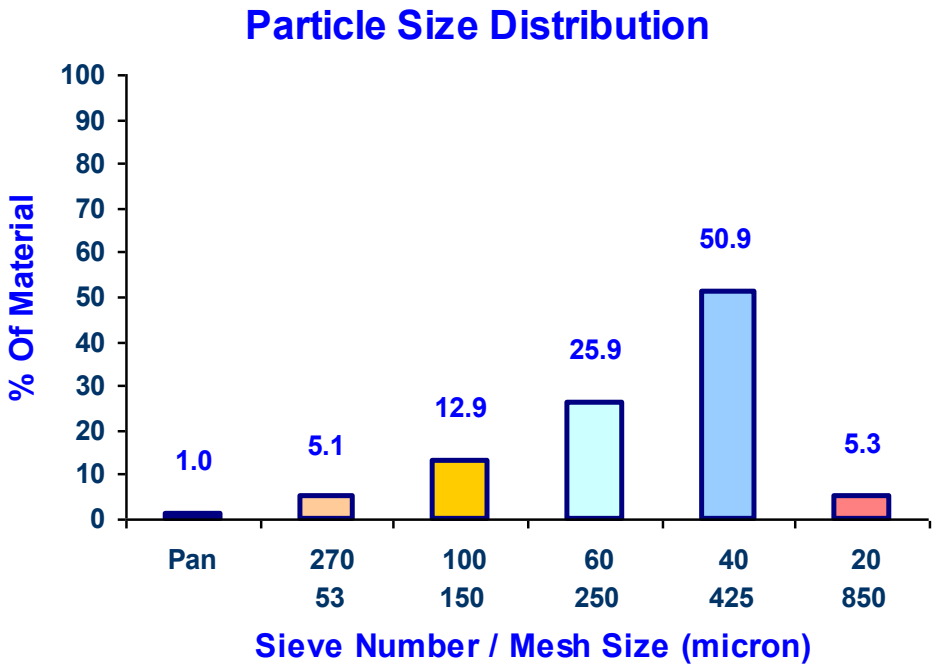
Sieve Analysis (% Retained)						
	Mesh #	Particle Size (mm)	Wheat Midds	Rice Hulls	Cal Carb	Vitamins
Coarse	20	0.85				
	40	0.425	2%	44%	50%	
	60	0.25	35%	40%	36%	Vit A (0.225) Vit E Ads (0.21)
	100	0.15	38%	14%	10%	Vit E SD (0.15) Niacin (0.1-0.3)
Fine	270	0.053	24%	2%	4%	Biotin (0.15) Vit D3 (0.05) B1 (0.125) B2 (0.13) B6 (0.12) CalPan (0.10)

Particle Size Distribution



Rice hulls and Cal Carb

The ideal bell-shaped distribution of a micropremix can only be attained if a good quality carrier (wheat middlings or rice hulls) with a similar particle size distribution to active particles, is used.



Cal Carb Only

Fine vitamin particles are not accommodated and can segregate easily if the carrier has a large particle size

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Premix Composition and Effect On Homogeneity

Vitamin A	Vitamin D3	Vitamin E	Thiamine Cl	Riboflavin	Niacin	Pantothenic Acid	Pyridoxine	Premix Composition
17.2	16.8	11.1	17.16	6.38	12.97	11.51	7.61	Premix contains > 50% Rx E Ads with 8% rice hulls
2.4	6.7	2.4	10.64	4.45	4.84	4.46	6.70	Premixes with 50,000 – 124,000 mg/kg B1
5.22	-	6.8	12.58	7.30	3.00	7.11	5.45	
-	4.7	4.7	19.69	5.20	4.32	-	7.28	
-	5.13	2.63	3.68	4.74	4.29	3.39	3.84	Premixes composed of spray dried or crystalline product forms. Min 20% carrier with mineral oil.
-	6.03	3.9	1.27	2.85	4.53	4.05	1.53	
-	-	2.9	3.46	4.13	2.23	5.18	2.04	
4.30	6.10	3.40	8.72	4.74	4.89	5.43	6.00	Premix with 30% carrier and mineral oil.

Industry Standard CV < 10

Premix Homogeneity

Ensuring correct carriers are used for components of blend to minimize segregation

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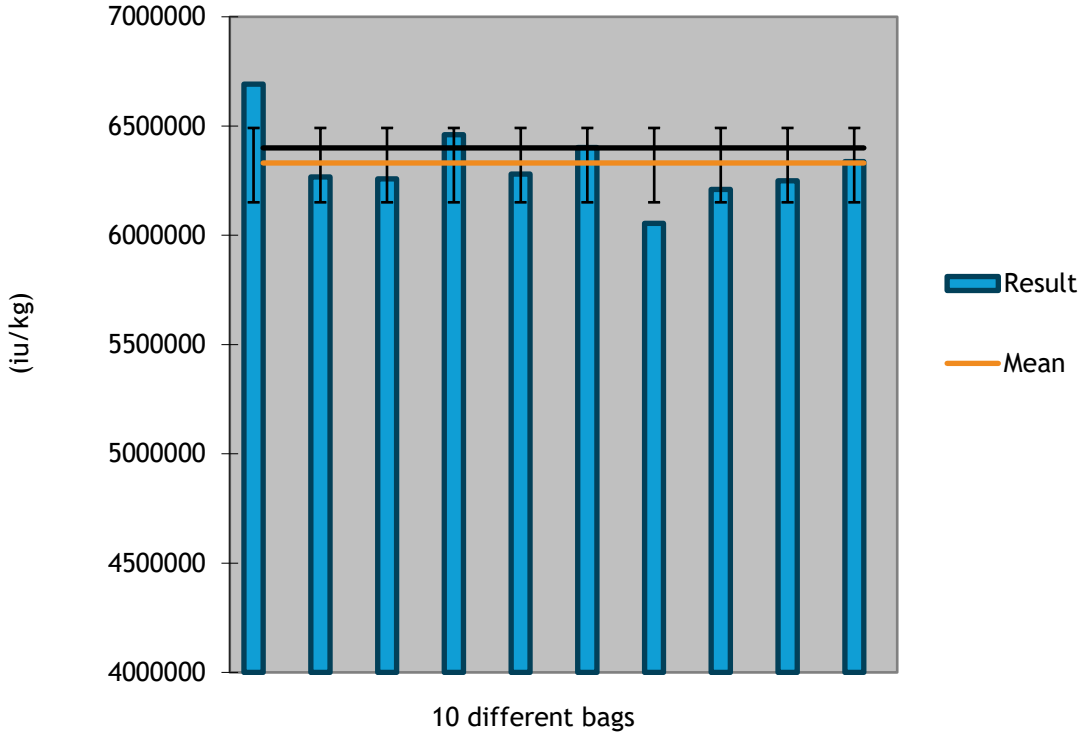
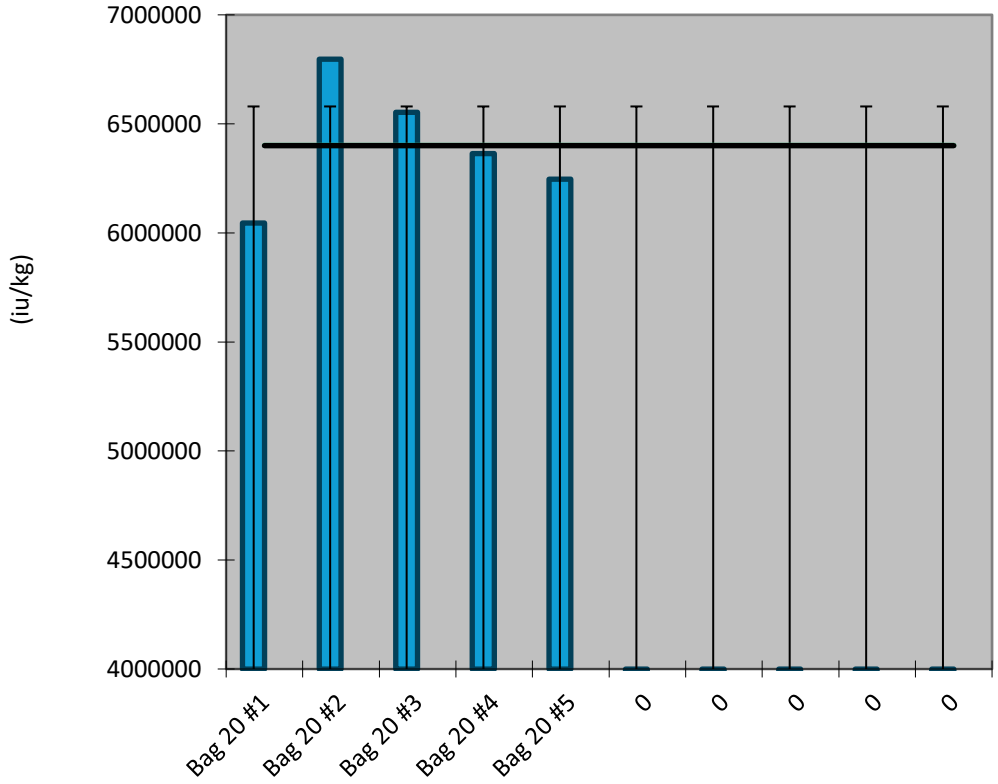
Homogeneity

- Composition of premix & tendency to separate.
- Variation associated with manufacturing is estimated using homogeneity testing
  - Maximum CV 7.5%, historical average 5%, CFIA GMP 10% for premixes. Use of Auto-sampler vs probe or scoop may influence results
- Homogeneity test demonstrates this where 5 samples from one bag were tested to compare to overall CV





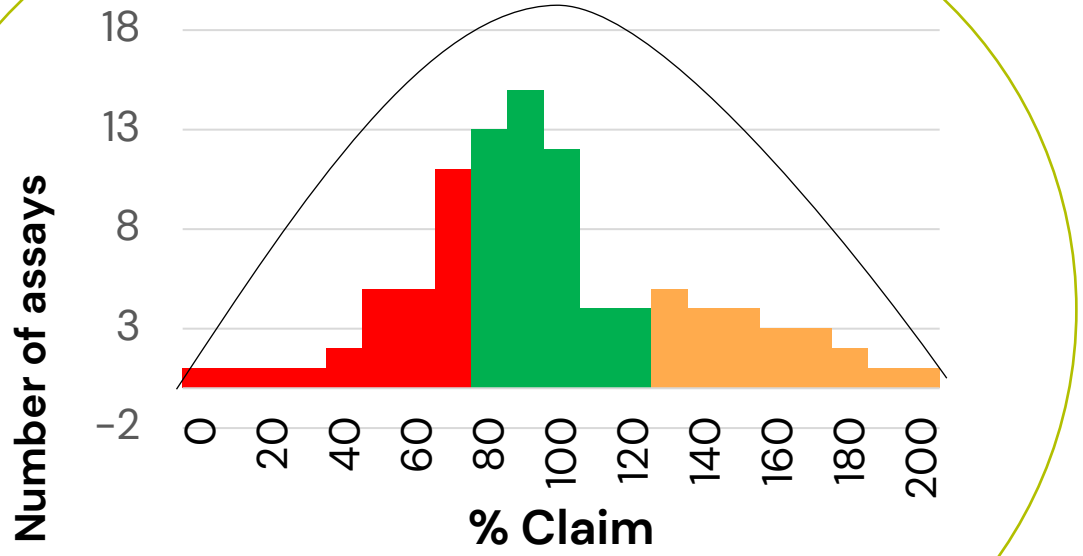
Sample size in premix analysis

- Sample on right is 5 g of premix
- This is the amount of sample used for Vitamin D analysis

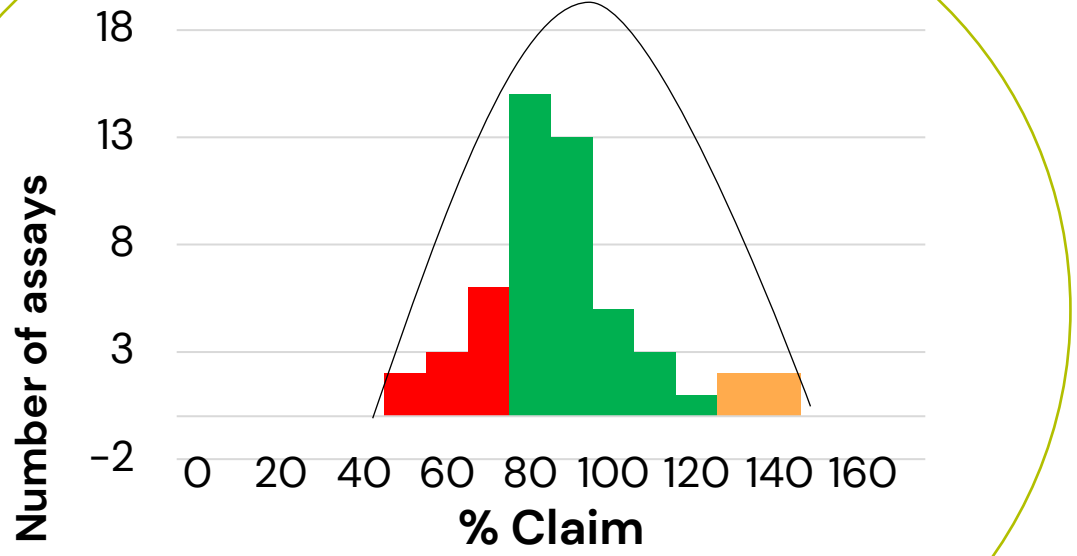
- Sample on left is 1.5 g of premix
- Methods for all other vitamins use between 1 and 2 g of sample

1 to 5 g sample is analyzed
out of 3000 kg batch

Vitamin A results based on expected level of nutrient (feed)



% Claim – Finished Feed – <10,000 IU/kg



% Claim – Finished Feed – >10,000 IU/kg

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Recommended Release Ranges

Nutrient	TMAS		3rd Party Labs		AAFCO	
	Min %	Max %	Min %	Max %	Min %	Max %
Ascorbic Acid*	70	130	75	125		
Beta-carotene	75	125	75	135		
Biotin*	-	-	60	140		
Folic Acid*	-	-	60	140		
Niacin	80	120	75	140	75	125
Pantothenic Acid (B5)	75	125	70	140	75	125
Pyridoxine (B6)	70	130	70	140		
Vitamin A	75	125	75	125	70	130
Thiamine (B1)	70	130	70	140		
Vitamin B12	-	-	60	140	55	145
Riboflavin (B2)	75	125	75	140	70	130
Vitamin D	70	130	75	125		
Vitamin E	75	125	75	125		

* Range may be tightened based on expected level and/or source.

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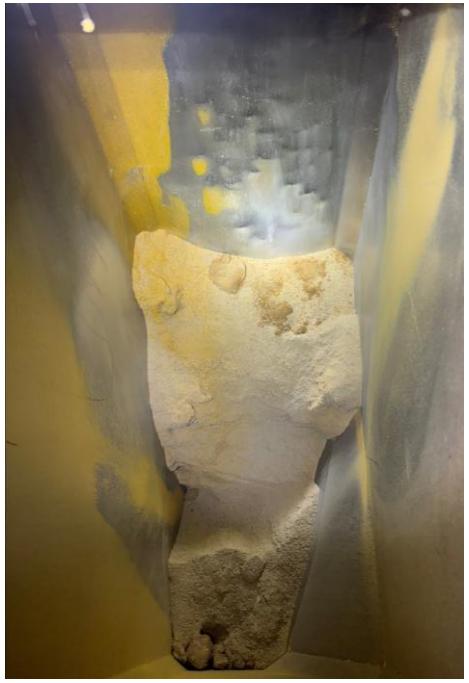
Ingredient Constraints

- Hygroscopic ingredients?
- Is a flow agent required?
- Max. 20% Choline chloride, 10% Niacin

- Homogeneity (i.e., high vitamin E)
- Would this formula tend to segregate?
- Should the premix be diluted or concentrated
- Does the premix contain fine particles; will it be electrostatic?

Evaluate new products for use in your micropremix

- Some ingredients can react with the vitamins or minerals and cause clumping very quickly.
- Prevents premix flowing out of bin.
- Ensure we do not cause issue for our internal production or customers down the line.



Formulation Constraints

Fire or Smoldering:
- Risk of dust explosion in case of mechanical spark, or storage with no safeguards.
- MIE is 1 mJ - 3 mJ
  - Niacin, E Adsorbate
- Flammability properties are highly impacted by particle size and ambient conditions.
- Must have maximum 50% cumulative 1-3 mJ MIE materials

Clumping
- Hygroscopic
- Choline, Betaine, Ascorbic Acid, Amino acids
- Lysine and Taurine in particular limit to 40% total inclusion

Unstable combinations:
- Iron Fe3+ with Iodide I-, Cu2_ with Iodide I-, Sodium diacetate and magnesium chloride

Colour/Chemical Change
- Acid –base reactions (release of CO2 if moisture + heat, inflates bag).
- Citric acid + carbonate

Global Stability Studies
What have we learned?

- There is no one-size fits all solution.
- Evaluate all factors impacting stability, homogeneity and premix quality and determine how they align with the requirements of your operation and the animal's nutritional needs.

We bring progress to life

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