



balchem

Not All Rumen Protected Products Are Created Equal

Clay Zimmerman, Ph.D.
Balchem Corporation
December 12, 2023

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Balchem Corporation

Our vision

is clear – to make the world a healthier place.

Our mission

is focused – to build a global nutrition and health company delivering trusted, innovative and science-based solutions to our customers.

- Founded in 1967
- Basic in microencapsulation technology
- 3 core business units:
 - Human Nutrition and Health
 - Animal Nutrition and Health
 - Specialty Products
- 7 Technology Centers across the US and Europe
- Microencapsulates are heavily used in the Human Nutrition and Health and Animal Nutrition and Health businesses

Balchem is the global leader in microencapsulation technology

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Application of Encapsulates in Balchem's HNH Business



There are many uses for Balchem's encapsulates in our Human Nutrition and Health Business

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Application of Encapsulates in Balchem's ANH Business

Monogastric species:



Ruminants:



There are many uses for Balchem's animal encapsulates across many species

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Encapsulation Technology

“Not all encapsulated products are created equally; consequently, there are vast differences in their efficacy and stability.”

Emma Wall, January 3, 2011 Feedstuffs.

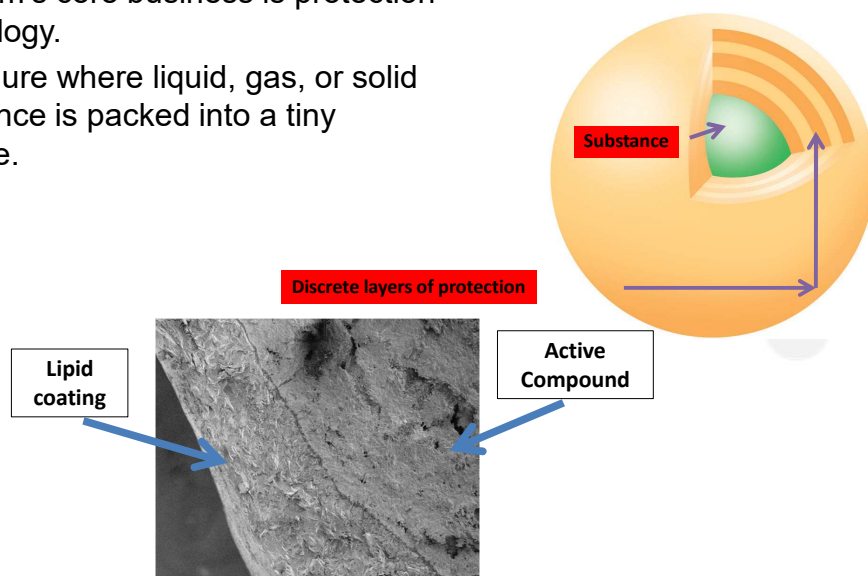
- Encapsulation is a generic term. Huge differences can exist between products that protect that same compound.
- Variation due to:
 - Starting form and mode of inclusion
 - Coating
 - Manufacturing process

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Microencapsulation

- Balchem’s core business is protection technology.
- Procedure where liquid, gas, or solid substance is packed into a tiny capsule.



Encapsulates Differ In:

- Design
- Technology
- Performance
 - Stability in feed mixing and TMR's
 - Animal performance

There are large differences in encapsulated products

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Encapsulates Differences are Due to:

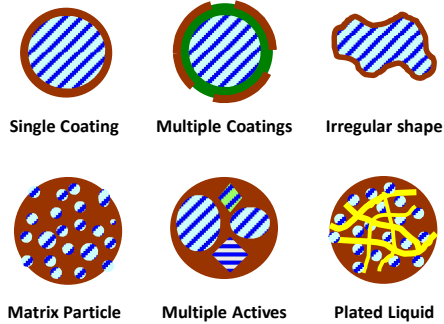
- Starting form and inclusion rate of the nutrient(s)
- Coating system utilized
- Composition of the coatings utilized
- Manufacturing process

Many factors lead to differences in encapsulated products

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Encaps come in all shapes and sizes...



and will have very different characteristics

Agricultural applications typically use true single/multiple coatings or matrix particle technology

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Animal Encapsulates Come In All Shapes and Sizes...



This can lead to very different performance in the feed and the animal

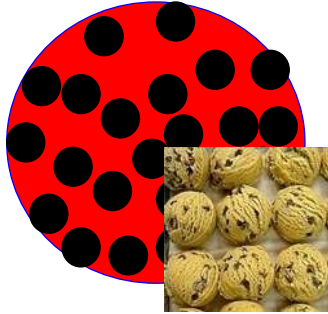
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Lipid encapsulation

Matrix encapsulation

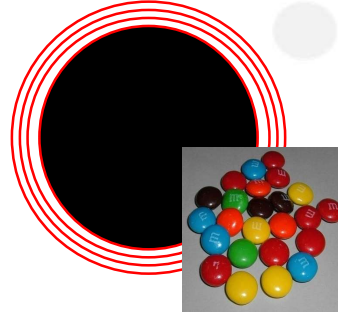
(also known as spray cooled encapsulates or SCE)



- *Compound at surface*
- *Reduced protection & stability*

True encapsulation

(also known as single layer coating (SLC) or multi-layer coating (MLC))



- *No compound at surface*
- *High protection & stability*

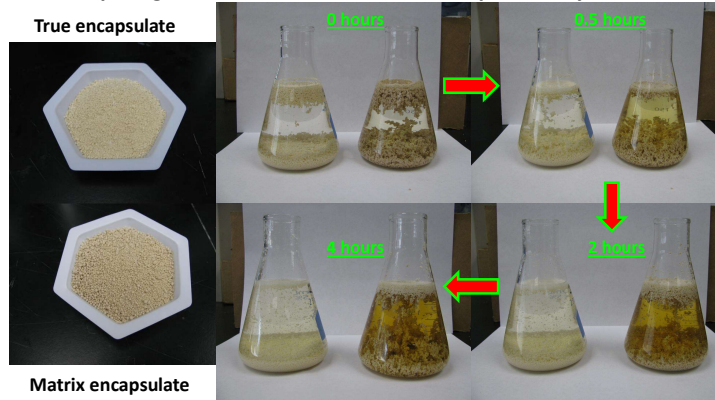
True encapsulates are preferred for ruminant applications

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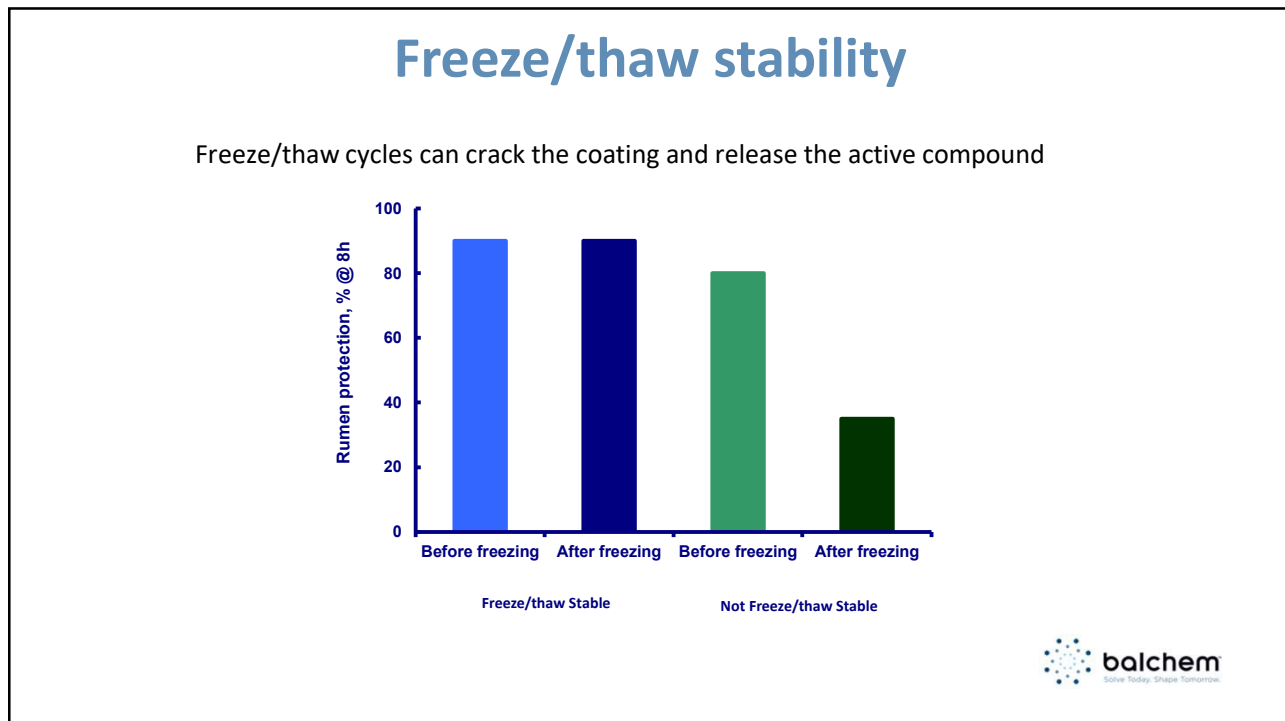
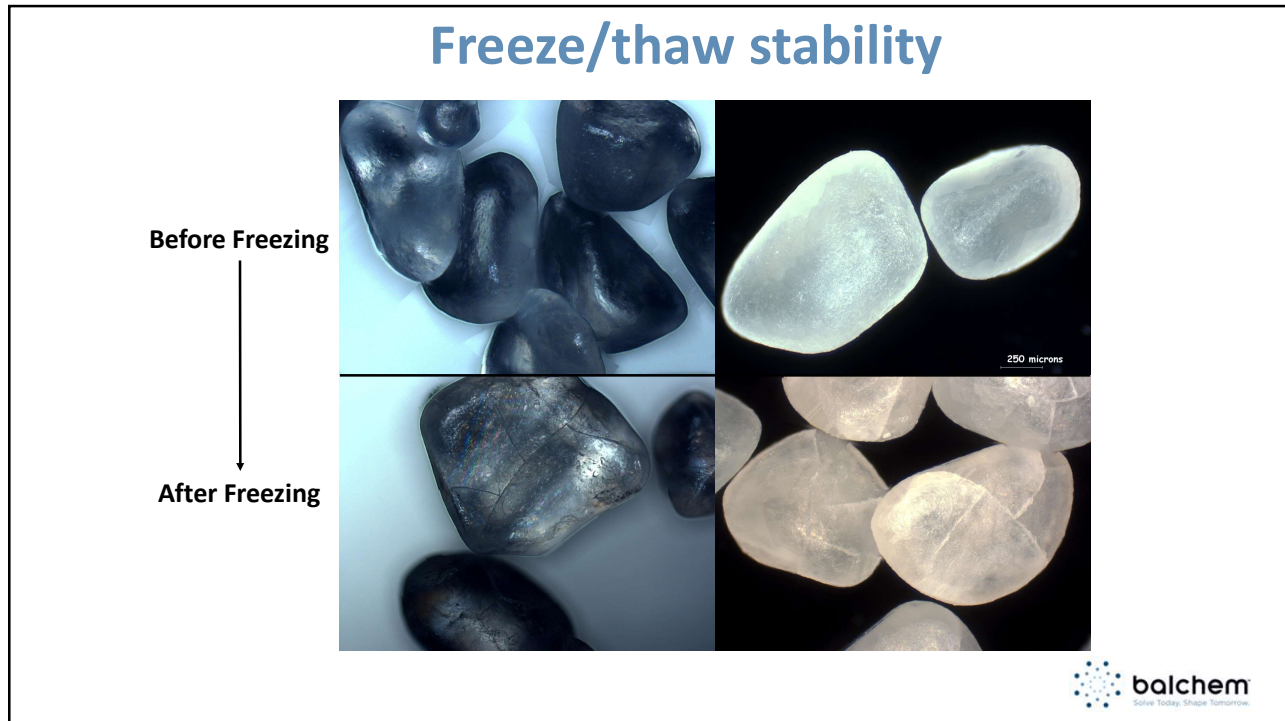
Action speaks louder than words but not nearly as often – Mark Twain

Comparing release of true and matrix encapsulated lysine in water

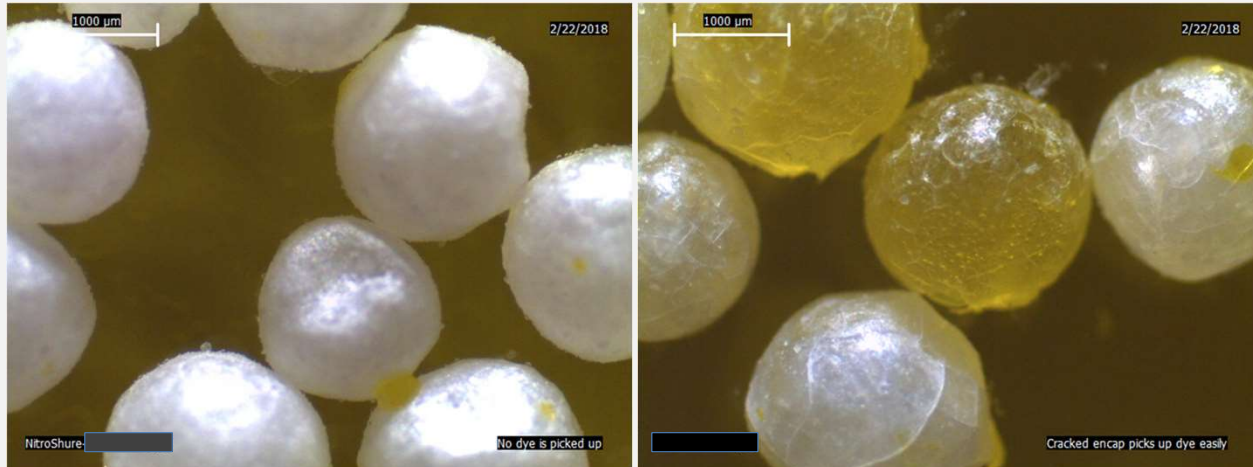


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NitroShure vs a competitor product that shows cracks in the coating



NitroShure

Competitor

Why Encapsulate Nutrients for Ruminants?

- Targeted delivery in the GI tract
- Rumen fermentation often results in breakdown of these important compounds

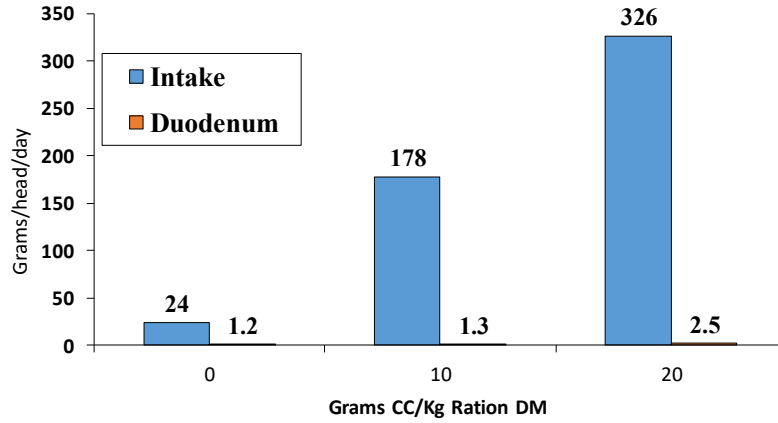
Compound	Rumen degradation, %	Reference
Choline	98	Sharma and Erdman(1989)
Niacin	94	NRC (2001)
Lysine	93	Robinson et al. (2005)
Methionine	87	Volden et al. (1998)

Many nutrients need to be protected from ruminal degradation for effective absorption by the cow

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Why Choline Must be Encapsulated for Ruminants



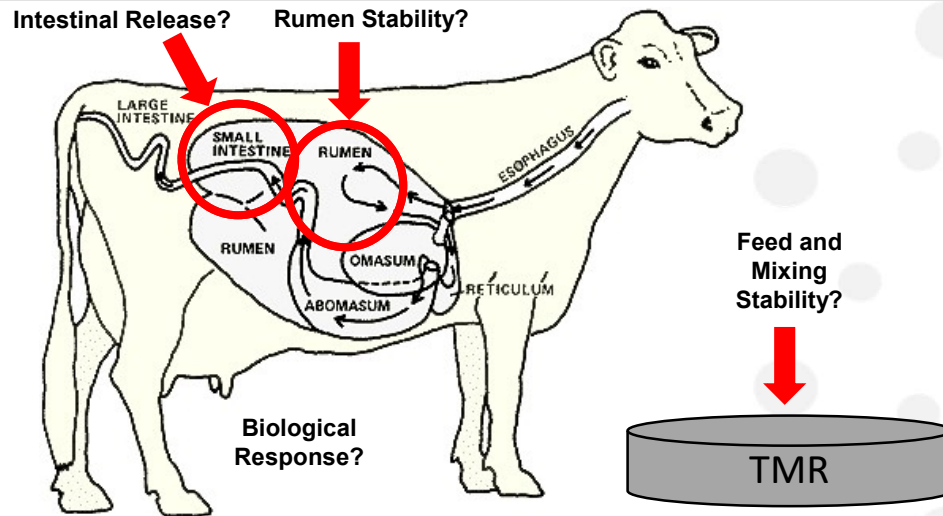
Sharma and Erdman (1988) J. Dairy Sci. 71:2670-2676

Choline chloride is almost completely degraded in the rumen

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Rumen Protected Product Characteristics



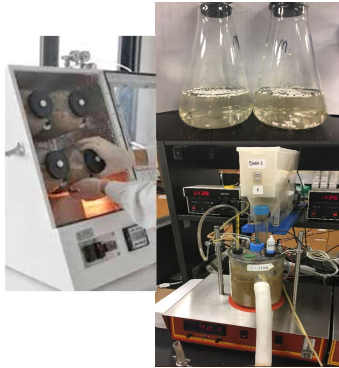
If any one of these functions are compromised, the product may fail to deliver as expected

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Types of Testing for Evaluating Encapsulated Products

In vitro:
Lab techniques



In situ:
In the animal



In vivo:
In the animal



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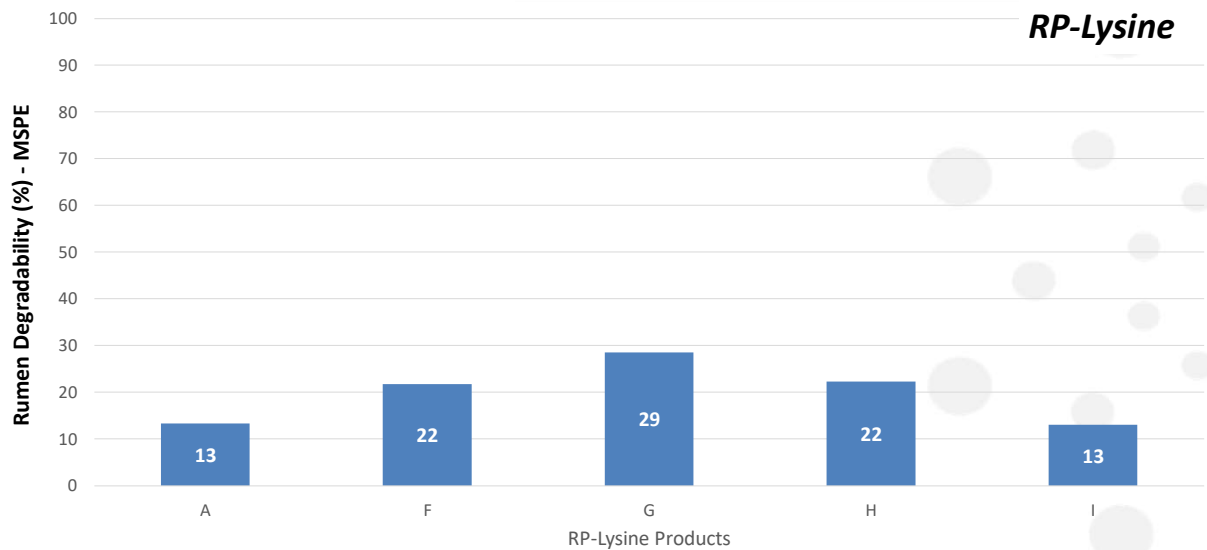


Ruminal Stability

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In Vitro Multi-Step Protein Evaluation (MSPE) – Rumen Degradability



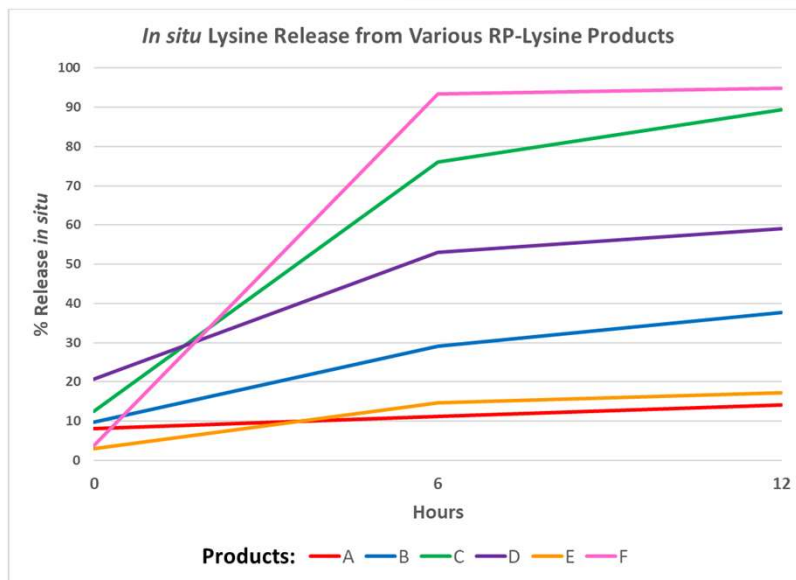
Technique: Ross et al., 2013. Proc. Cornell Nutrition Conference for Feed Manufacturers.

Testing: CVAS

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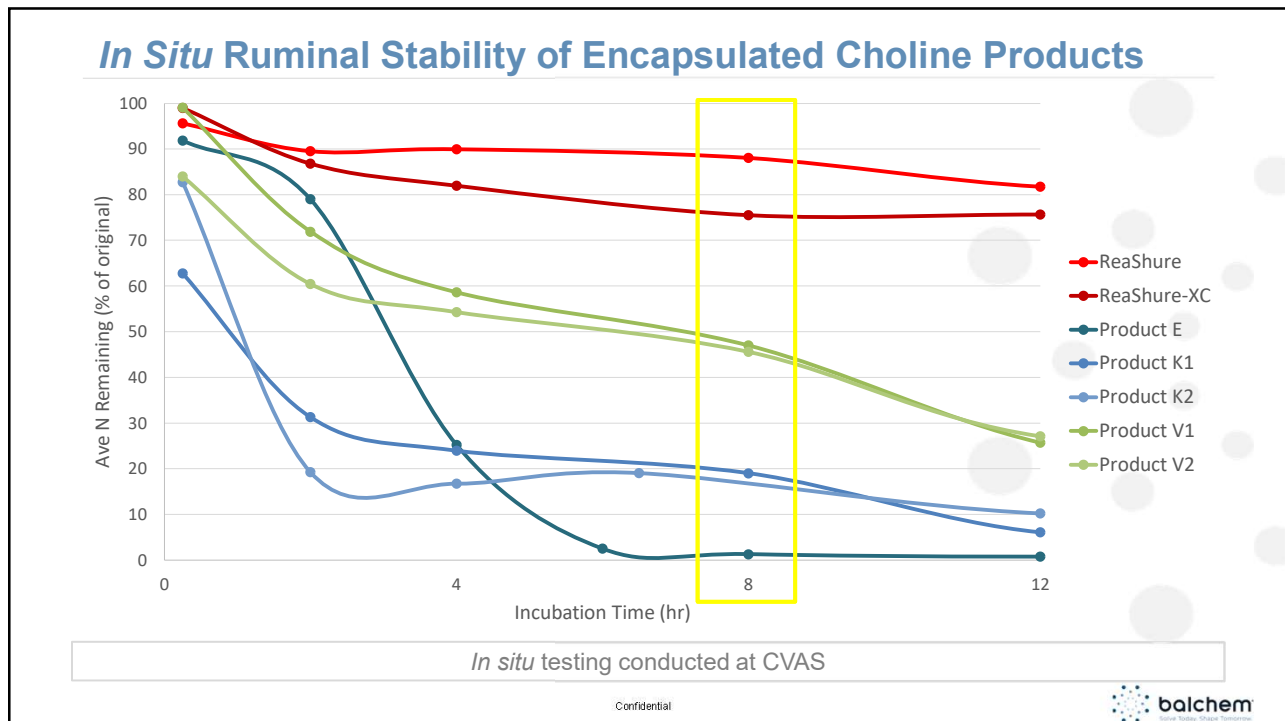
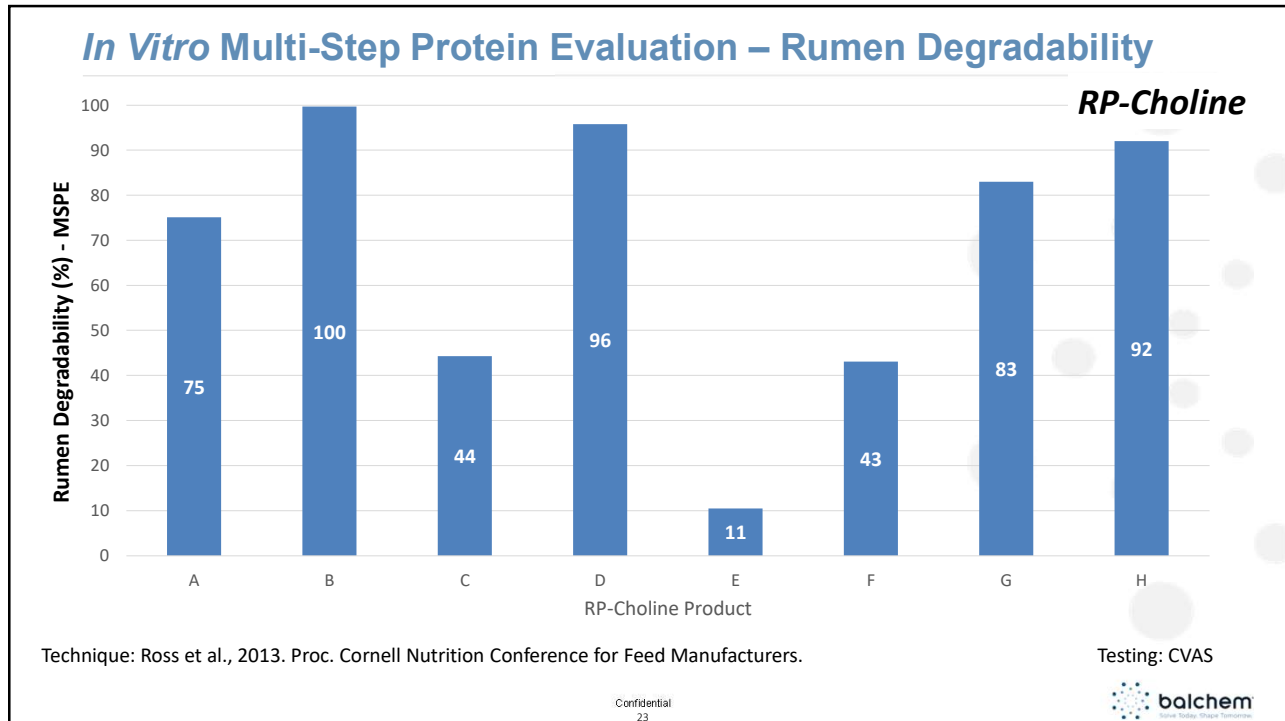
In situ Ruminal Release of RP-Lysine Products



Ji et al., JDS 2016

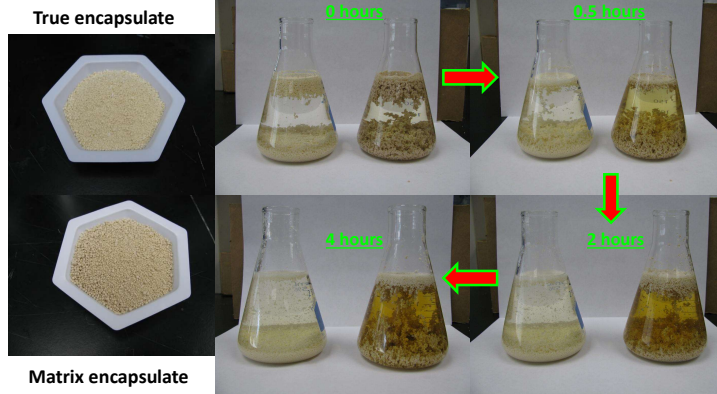
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Action speaks louder than words but not nearly as often – Mark Twain

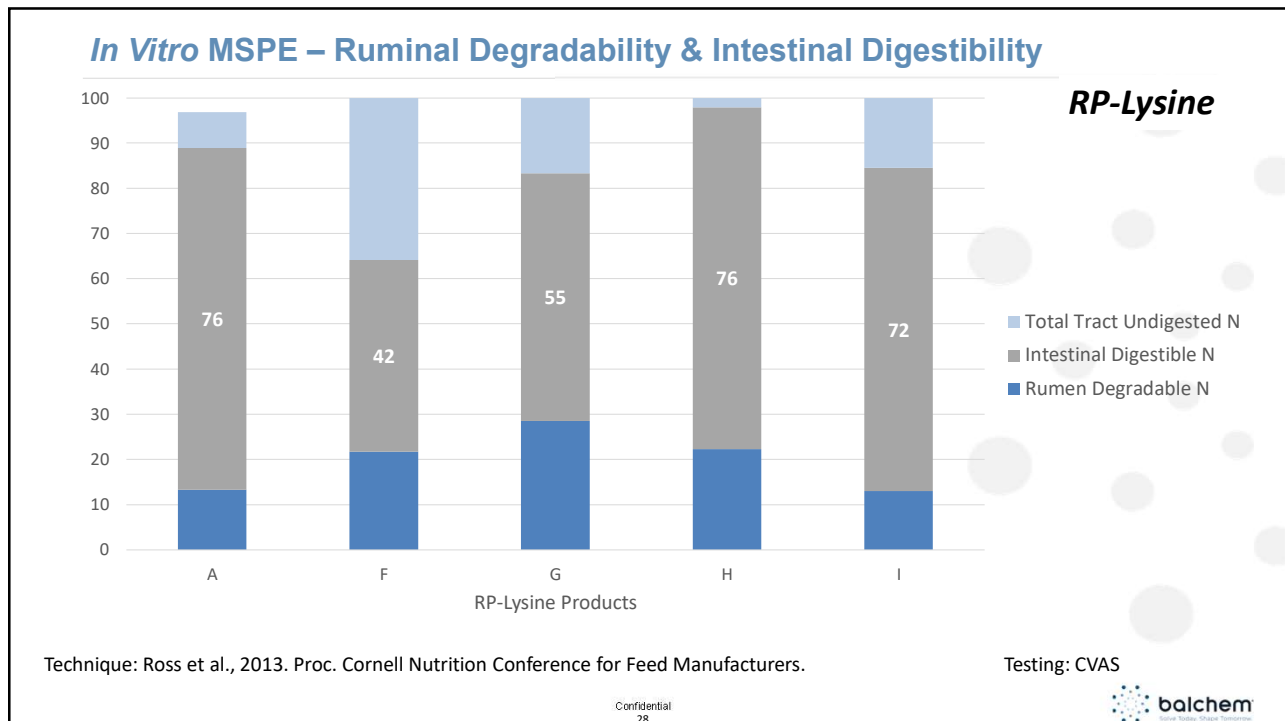
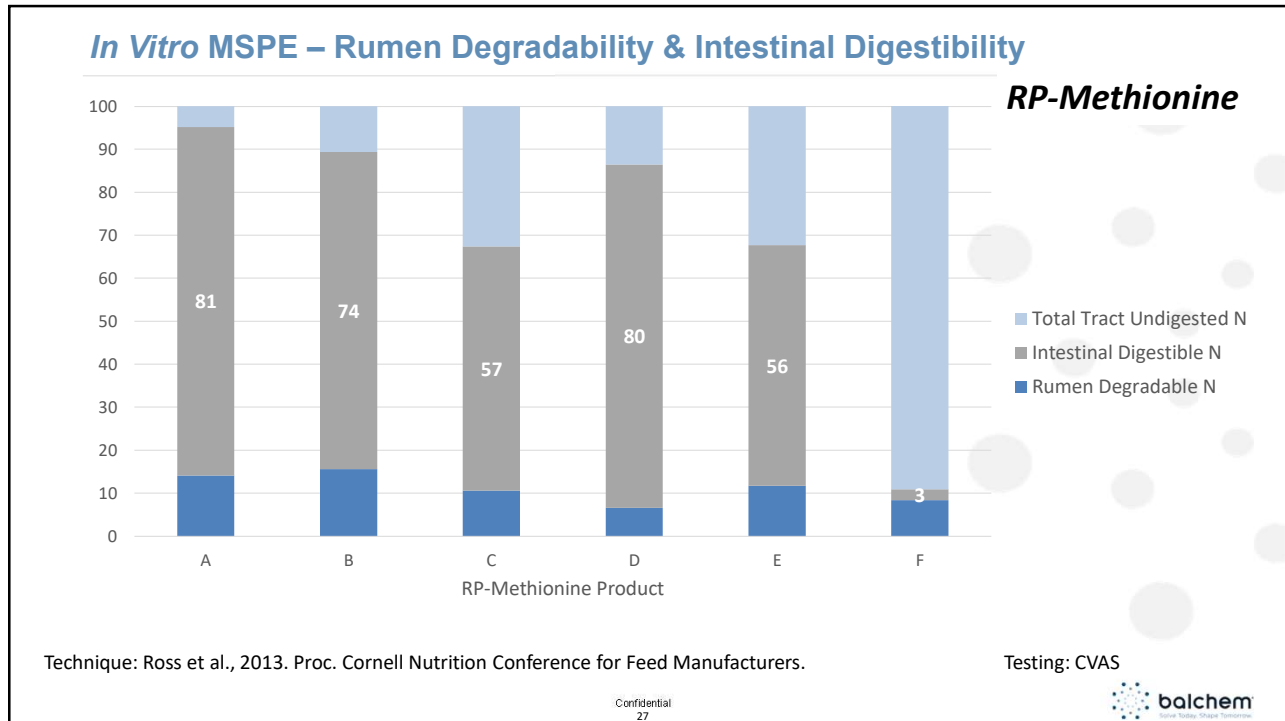
Comparing release of true and matrix encapsulated lysine in water



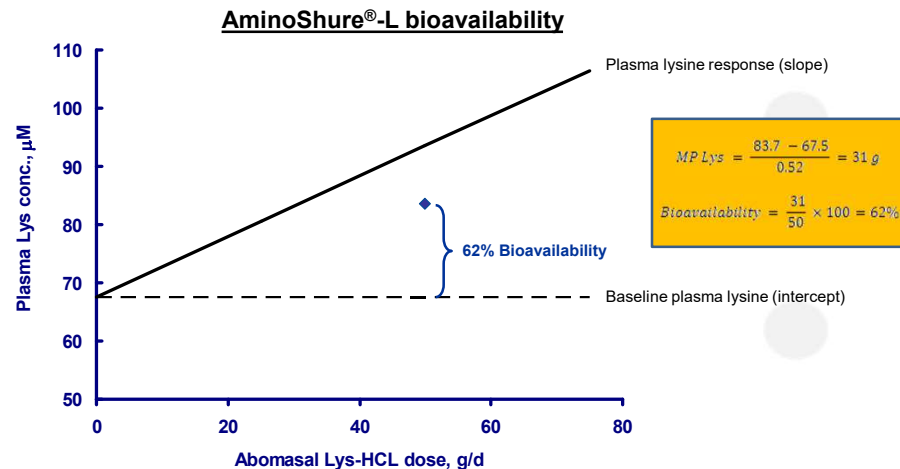
Intestinal Release (Bioavailability)

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Rumen-Protected Lysine Bioavailability: *AminoShure*[®]-L



AminoShure[®]-L
Precision Release Lysine

J. Dairy Sci. 92(Suppl. 1):T295. (Abstr.) - 2009

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Selenomethionine Technique

- *In vivo* method
- Products are fed
- Technique uses milk selenomethionine (from added dietary Se-yeast) as a tracer of Met in milk
- Measures changes in milk Seleno-methionine concentration to determine how much of an RP-Met product is utilized in the mammary gland
- Published procedure: **Weiss, W.P., and N.R. St-Pierre. 2009.** A method to quantify changes in supply of metabolizable methionine to dairy cows using concentrations of selenium in milk. **J. Dairy Sci. 92:2835-2842.**

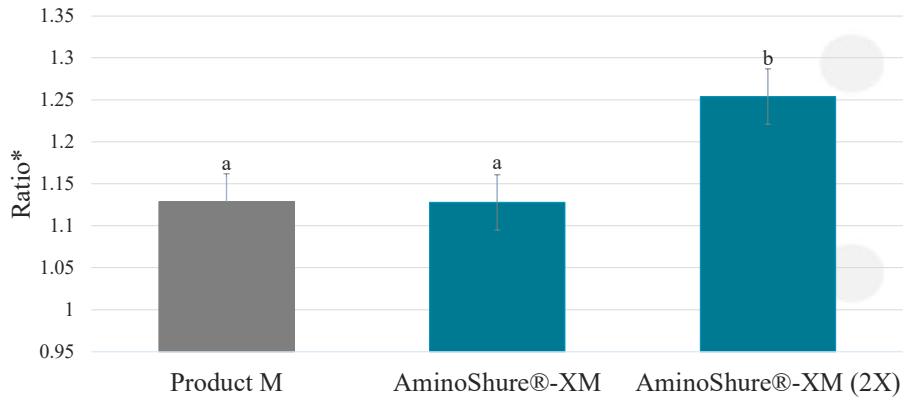
AminoShure[®]-XM
Precision Release Methionine

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Results

Effect of rumen protected Met supplementation on MP-Met supply in milk relative to the basal treatment



AminoShure-XM was equal in methionine bioavailability to Product M

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Stable Isotope Technique – Virginia Tech

AminoShure®-XM

Plasma Appearance¹ Bioavailability²

51.2%

55.0%

¹Percent of Met appearance in plasma. Calculated as the grams of Met absorbed into blood per gram of Met fed

²Predicted bioavailability corrected for 7% loss during first pass

Equal methionine bioavailability results with two different *in vivo* methodologies

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CNCPS Characterization of *AminoShure*[®]-*XM* from University Studies

Item	
Methionine, %	70
Rumen bypass, %	80
Intestinal Availability, %	68
Methionine Bioavailability, %	54.25
Metabolizable Methionine, %	38.0

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Feed and Mixing Stability

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Balchem Encapsulate Mixer Studies

Objective: Determine mixing stability of RP-products in a mineral mix

- Relatively quick
- Small batches (100 lbs/45 kg)
- Have tested RP-choline, RP-lysine, RP-methionine and slow-release urea products.

- **Mineral:**

1. Sodium BiCarb
2. Limestone
3. Mag Ox
4. Soy Oil (dust control)

- **Recipe:**

1. 90-98 lbs (41-44 kg) of mineral mix
2. 2-10 lbs (1-4.5 kg) of RP-choline, RP-AA, or encapsulated urea
3. Mix for 3 minutes

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Small Ribbon/Paddle Mixer



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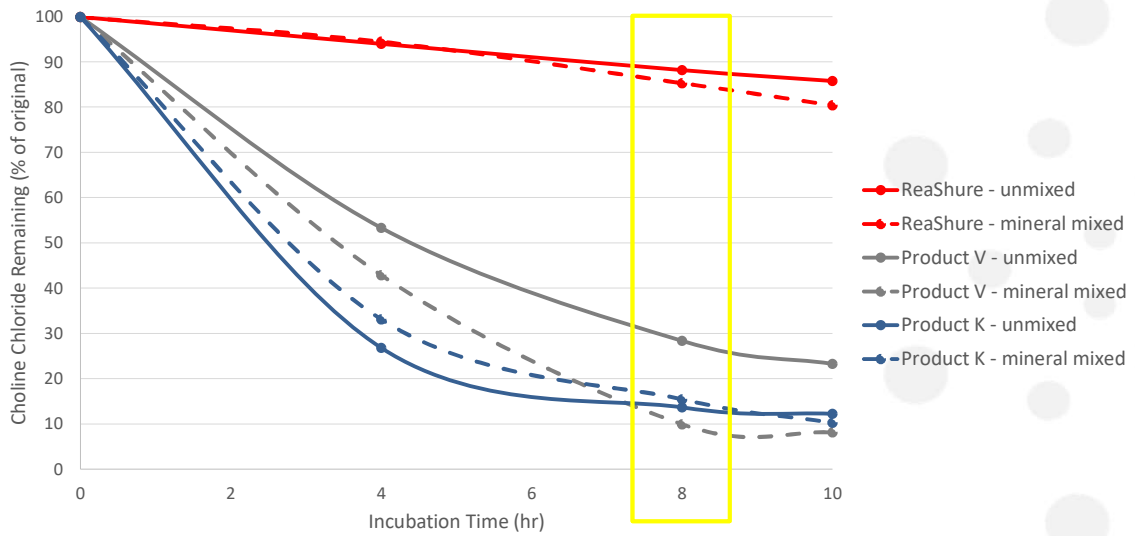
Small Ribbon/Paddle Mixer



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Mix Stability Test Results – RP-Choline Products

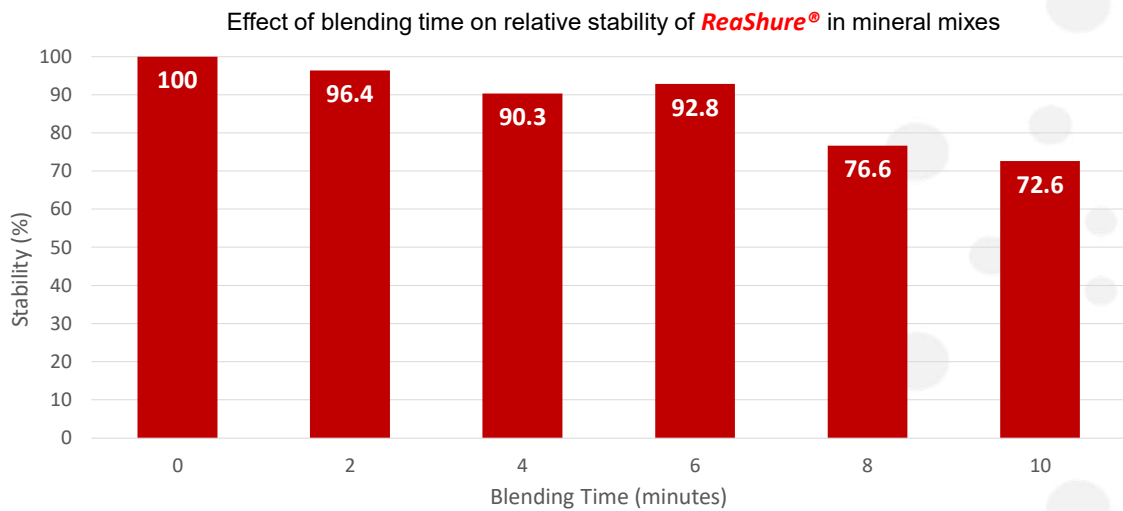


'Product V' incurred damage from the mineral mixing which compromised its ability to adequately protect the choline

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Blending Time Test – *ReaShure*[®]



Keep mixing time to 4 minutes or less in a mineral mix to achieve optimal product performance

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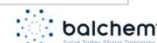


General Mixing Recommendations – Encapsulated products

- Mineral mixing times should be ≤ 4 minutes to minimize excessive mixing and unnecessary abrasion
- Add encapsulated products as late as possible into the mixer as one of the final ingredients to minimize mixing time.
- Having at least 50% non-mineral ingredients in the formula greatly reduces potential abrasion of encapsulated nutrients
- Keep encapsulated products dry in sealed bags. Store below 120° F (50° C). Recommended storage temperature 50° - 90° F (10° - 32° C).

To maximize efficacy of ruminant encapsulates, it is best not to overmix products

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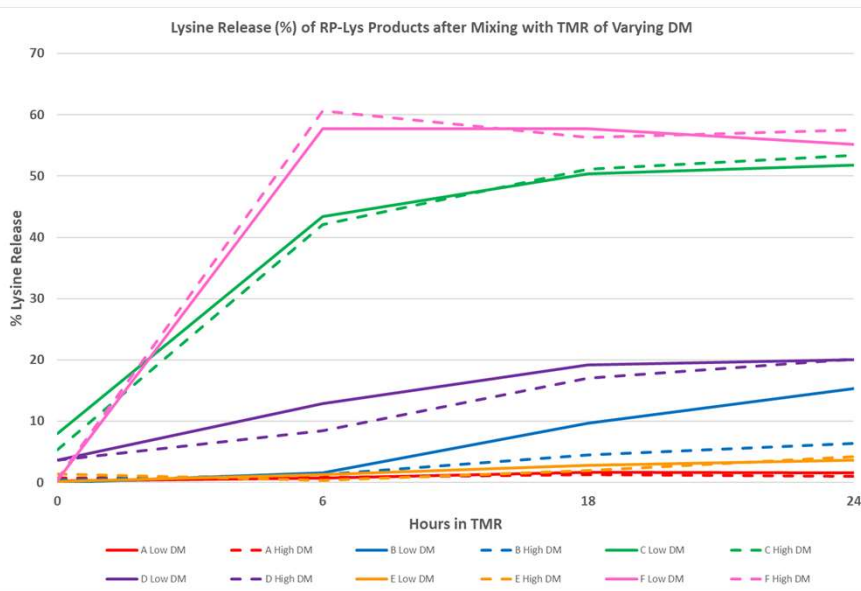


TMR Stability

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TMR Stability (Release) of RP-Lysine Products



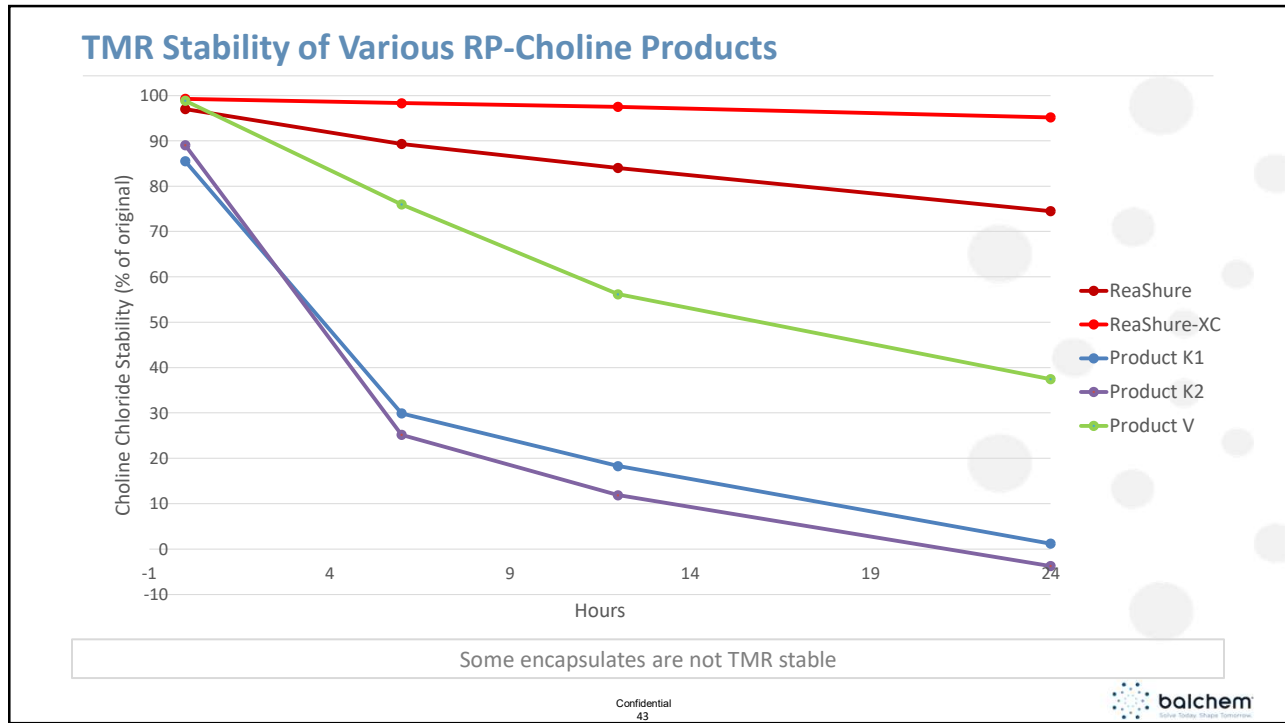
Low DM = 40.6% DM

High DM = 51.8% DM

Ji et al., JDS 2016

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Biological Response

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Rumen-Protected Lysine: *AminoShure*[®]-L

	AminoShure [®] -L 0 g/d	AminoShure [®] -L 30 g/d	AminoShure [®] -L 60 g/d
DMI, lbs/day	52.2 ^a	54.2 ^b	55.1 ^b
Milk yield, lbs/day	85.1 ^a	90.8 ^b	90.2 ^b
Milk Fat %	2.91 ^a	3.10 ^b	3.15 ^b
Milk fat yield, grams/day	1112 ^a	1276 ^b	1271 ^b
Milk Protein, %	3.10	3.01	3.06
Milk protein yield, grams/day	1194 ^a	1239 ^{ab}	1249 ^b
Milk nitrogen efficiency	29.9%	30.5%	30.2%

J. Dairy Sci. 92(Suppl. 1):T294. (Abstr.) - 2009

AminoShure[®]-L
Precision Release Lysine

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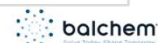
Rumen Protected Methionine

Item	Treatments			SEM	P-Value
	Control	RP Met 1	<i>AminoShure-XM</i>		
DMI, lbs/d	63.1	64.2	63.1	4.6	0.925
Milk yield, lbs/d	99.6	100.8	99.6	3.1	0.952
Milk Fat, %	3.62	3.50	3.51	0.29	0.255
Milk Fat, g/d	1620	1590	1590	120	0.690
Milk protein, %	3.02^a	3.11^b	3.12^b	0.05	0.024
Milk protein, g/d	1360	1420	1410	50	0.159
Milk Lactose, %	4.84	4.83	4.85	0.12	0.736
Milk Lactose, g/d	2180	2210	2190	70	0.913
MUN, mg/dL	11.0	11.2	11.4	1.19	0.440
SCC, cells/ml	187	202	174	50.2	0.364
ECM, lbs/d	101.6	102.3	101.6	3.6	0.936

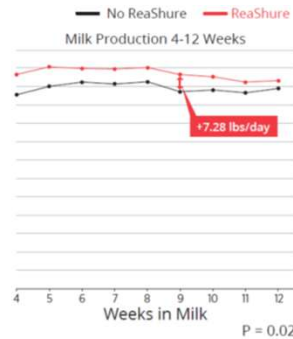
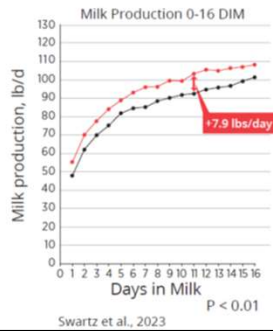
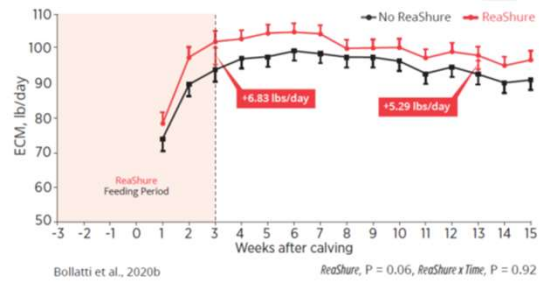
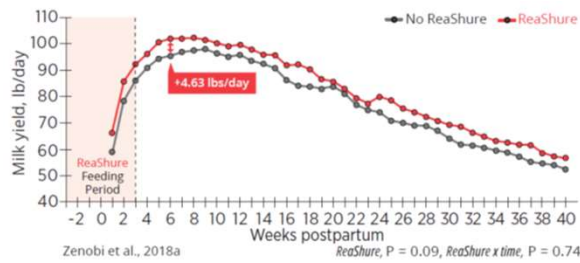
Fleming et al., JDS 2019

Supplementation of 2 different RP methionine products increased milk protein %

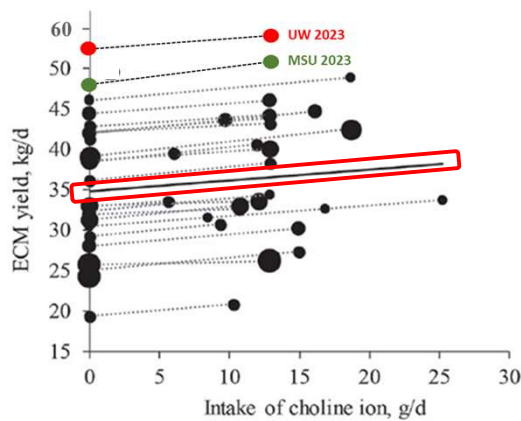
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Positive Benefits of **ReaShure**® Continue After Supplementation



Holdorf et al. & Swartz et al., 2023 Production Extremely High Compared to RPC Meta Analysis



4.4 lb/2.0 kg ECM response with **ReaShure** supplementation, even at 121 lbs (55 kg) of ECM

- Michigan State trial results expressed as milk yield

Modified from Arshad et al., JDS 2020

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Summary

- There are many differences in encapsulated products for dairy cows including:
 - Design of product
 - Coating types, amount, and composition
 - Manufacturing differences
 - Nutrient content
 - Bioavailability
 - Feed stability
- True encapsulates (MLC) are preferred for ruminant applications
- There are 4 important features of a good ruminant encapsulate:
 - Good ruminal stability
 - Good nutrient bioavailability
 - Feed and TMR stability
 - Biological performance

Thank you for your attention today!

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Questions?



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