Trace Mineral Source: Impact on Feed Quality and Animal Health

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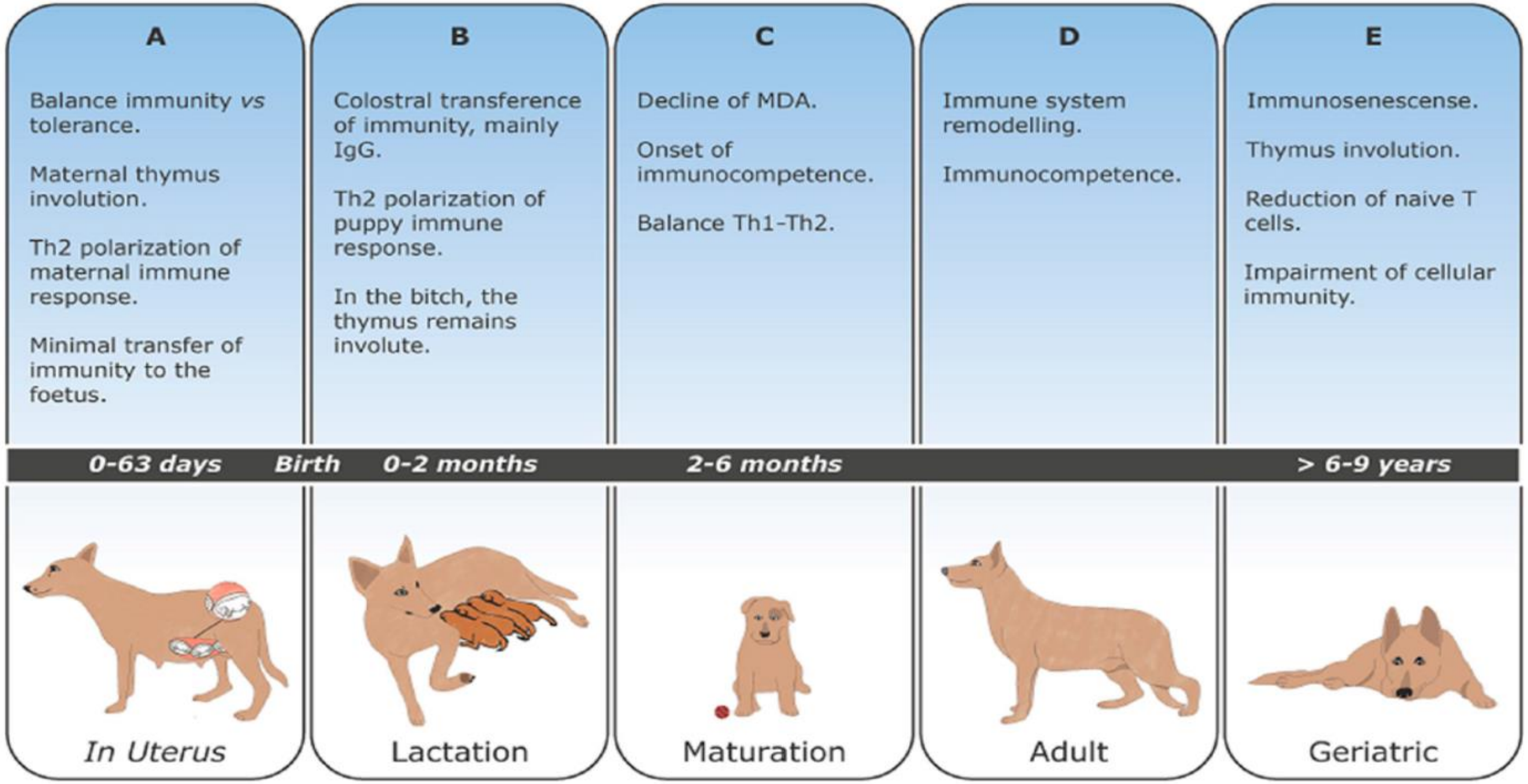
MINERAL MANAGEMENT

Global Pet Trends

- Traceability/sustainability and responsible sourcing
- HEALTH and WELLNESS
  - Preventative and functional health support
  - (Immuno-nutrition, microbiome support and development)

Major Changes in the Dog's Immune System



Vet. Sci. ***2019***, *6, 83; doi:10.3390/vetsci6040083*

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The immune system undergoes many changes over the different life cycle or course

- Developing and maturing in growing animals
- Potentially achieving peak function in fully grown/adult animals
- Gradually declining with old age

Distinct immune features are present during each life cycle

but a common factor throughout the life cycle is

the need for adequate supply of micronutrients in supporting immune function

Optimal immune function is dependent on a **healthy** immune system

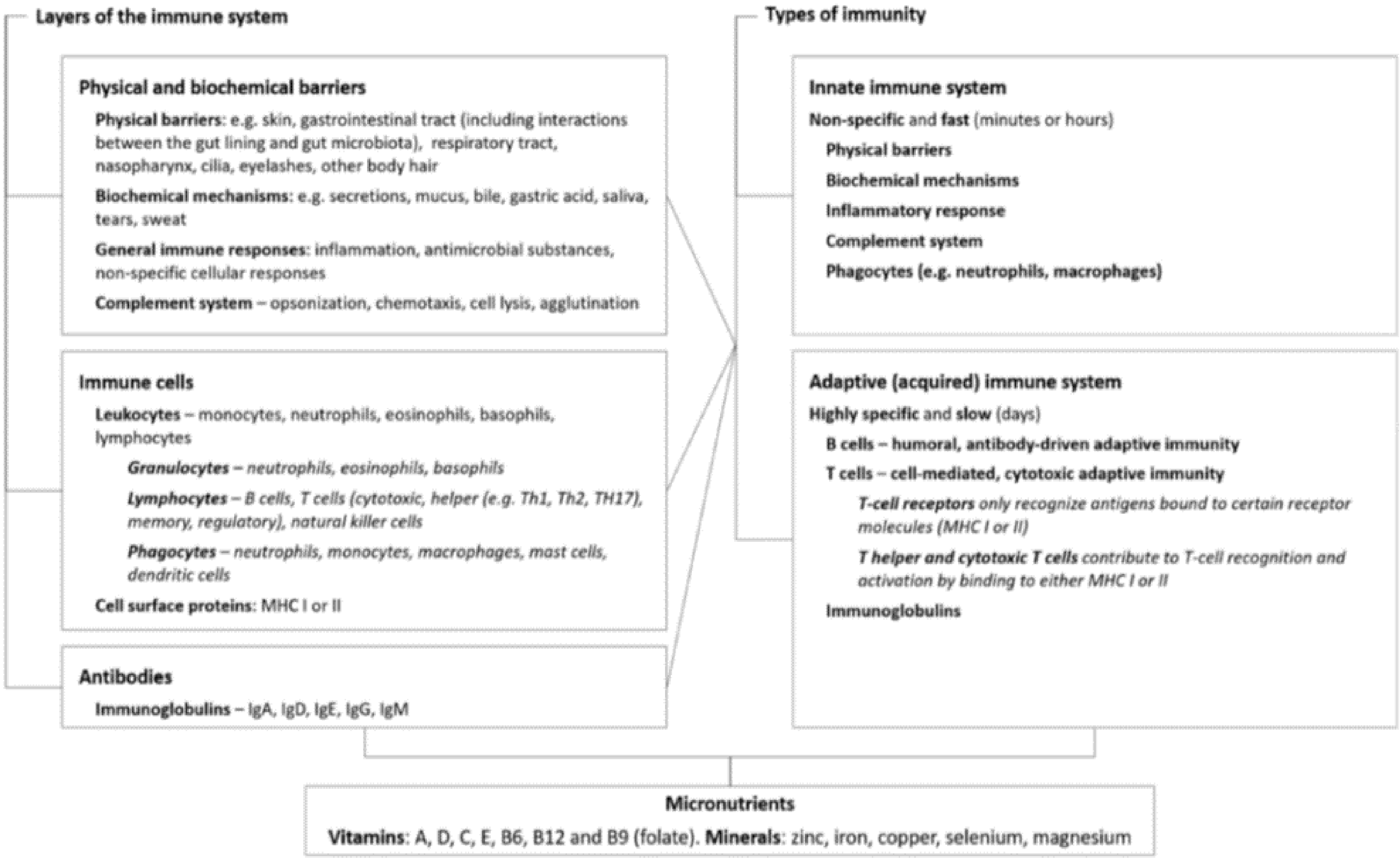
Adequate nutrition is crucial to ensure a good supply of the energy sources, macronutrients and micronutrients required for:

- Development
- Maintenance
- Expression of the immune response

Ingredient Quality and PETFOOD Claims

- Claims are often centered around functions directly related to vitamin and trace mineral status
- Overcompensating with high levels of Vitamins to support claims but supplementing with suboptimal levels and quality of trace minerals
- BALANCE
- Source and Quality: Shelf Life??

Vitamins and trace minerals are needed to support a healthy immune system



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Nutrients 2020, 12,236; doi:10.3390

Micronutrients and the immune system

- Complex, integrated immune system needs multiple specific micronutrients (vitamins and trace minerals) which play VITAL and SYNERGESTIC roles at every stage of the immune response
- Daily micronutrient intakes necessary to support IMMUNE FUNCTION might be higher than recommended rates for growth and maintenance

Vet. Sci. ***2019***, *6, 83; doi:10.3390/vetsci6040083*

Trace Mineral Supplementation: Can Form Impact Immunity?

Micronutrients are integral to immune function

BUT

nutrient interactions can be affected by many factors, including **trace mineral SOURCE**, leading to degradation and loss

Nutrient Requirements of Dogs and Cats (2006)

- The inactivation of almost all vitamins that occurs in the preparation of extruded foods and can foods is directly related to the temperature, duration of the processes ***AND the presence of free metals***

TRACE MINERAL SOURCE CAN IMPACT VITAMIN DEGRADATION AND OVERALL FEED QUALITY AND EFFICACY

Inorganic Trace Minerals

- Oxides
- Sulfates
- Chlorides
- Hydroxies

Organic Trace Minerals

- Complexes
- Chelates
- **Proteinates**
- Polysaccharides
- Proprionates
- **Selenium yeast**

Having minerals in less reactive forms (chelates) can decrease the loss of many vitamins compared to when minerals are present as sulfates, free metals or even organic trace minerals with lower stability

Are all organic minerals the same?

- Differences due to structure
- What the mineral is bonded to
  - Amino acids
  - Peptides
  - Organic acids
  - Sugars
- Production method

AAFCO Definitions for organic trace minerals

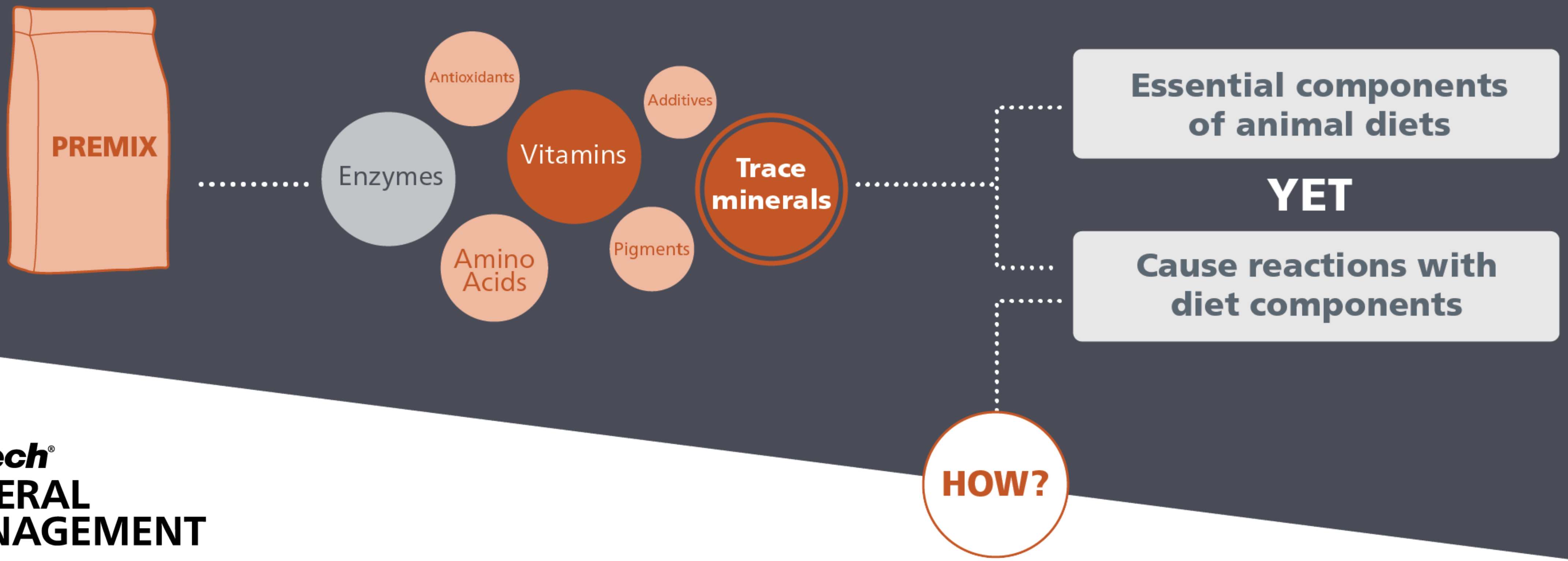
Table 1 AAFCO definitions for organic mineral complexes

Metal amino acid complex	The product resulting from complexing a soluble metal salt with an amino acid (<300 Da)
Metal (specific amino acid) complex	The product resulting from complexing a soluble metal salt with a specific amino acid
Metal amino acid chelate	The product resulting from the reaction of a metal ion from a soluble salt with amino acids with a mole ratio of one mole of metal to one to three (preferably two) moles of amino acids to form coordinate covalent bonds. The average weight of the hydrolyzed amino acid must be approximately 150 Da and the resulting molecular weight of the chelate must not exceed 800 Da
Metal proteinate	The product resulting from the chelation of a soluble salt with amino acids and/or partially hydrolyzed protein
Metal polysaccharide complex	The product resulting from complexing of a soluble salt with a polysaccharide solution declared as an ingredient as the specific metal complex

Trace Mineral Source:

Dietary Interactions

Trace mineral source and premix components



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HOW?

Antioxidants

Dissociated free mineral
▼
Free radical formation
▼
Antioxidant loss

Enzymes

Substrates react with inorganic mineral ions
▼
Lower substrate availability
▼
Reduced enzyme activity

Vitamins

Mineral oxidative action
▼
Functional instability
▼
Increased degradation

- The redox activity of transition metals can lead to ROS species (Fenton type reactions)
- ROS can oxidize a wide range of substrates

Trace mineral source and premix components

Trace Mineral Source and Antioxidant Stability

- Synthetic antioxidants (ex BHT) are routinely added to the premix as a "preservatives" or to limit oxidation of vitamins

- Trace mineral source can have an inhibitory effect on antioxidant activity of BHT

- Level of inhibition seem to be SOURCE dependent

TRACE MINERALS AND PREMIX COMPONENTS - ANTIOXIDANTS (BHT)

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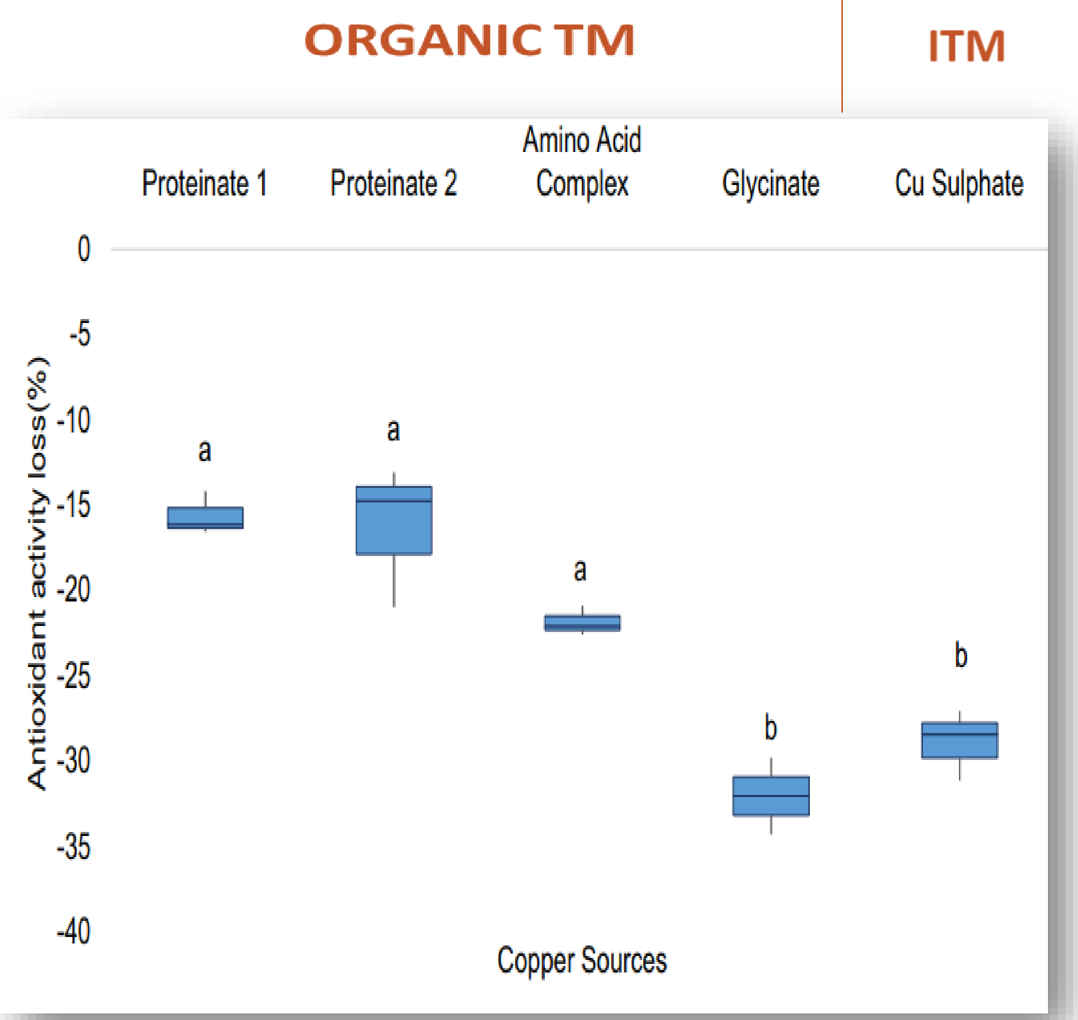
When analyzing the antioxidant activity of BHT in presence of different Cu Sources:

All Cu sources demonstrated an inhibitory effect on BHT

However

Proteinate 1 (15.6%)
Proteinate 2 (16.3%)
Amino acid complex (21.9%)
Cu Sulfate (28.9%)
Cu Glycinate (32.1%)



Concarr et al., SN Applied Sciences 3:564, 2021 (Bioplex-738 Concarr)

Trace Mineral Source and Enzyme Activity

- Trace minerals can influence enzyme function of various exogenous enzymes

- Trace minerals can affect phytase activity through direct interaction with the enzyme itself or indirectly via phytic acid

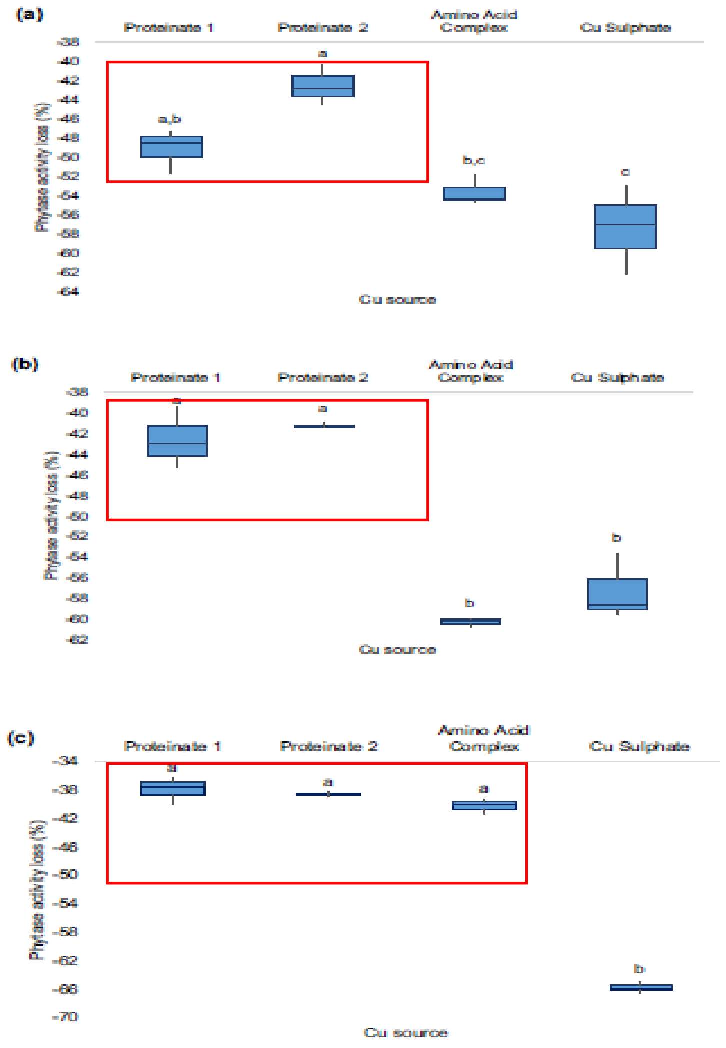
- Phytic acid is strongly negatively charged and chelate easily with metal ions to form soluble and insoluble complexes

- The insoluble complexes are less available to phytase and will thus lower the amount of phosphorus released

TRACE MINERALS AND PREMIX COMPONENTS - ENZYMES

Phytase activity loss after exposure to different sources of Cu:

- Cu had an inhibitory effect on phytase activity of all three phytases tested
- In general, Proteinate 1 and 2 elicited the lowest rate of phytase activity loss



Concarr et al, JAAN 9 (1), 2021 (**Bioplex-741 Concarr**)

Trace Mineral Source and Vitamin Degradation

- The presence of pro-oxidative TM within a premix can lead to Fenton type oxidizing reactions and subsequent degradation and loss of certain vitamins

- Use of organic trace mineral sources reduces vitamin activity losses by 40 to 50% during storage compared to adding inorganic trace minerals in a vitamin-trace mineral premix (Shurson et al., 2011).

TRACE MINERALS AND PREMIX COMPONENTS - VITAMIN E (alpha-tocopherol acetate)

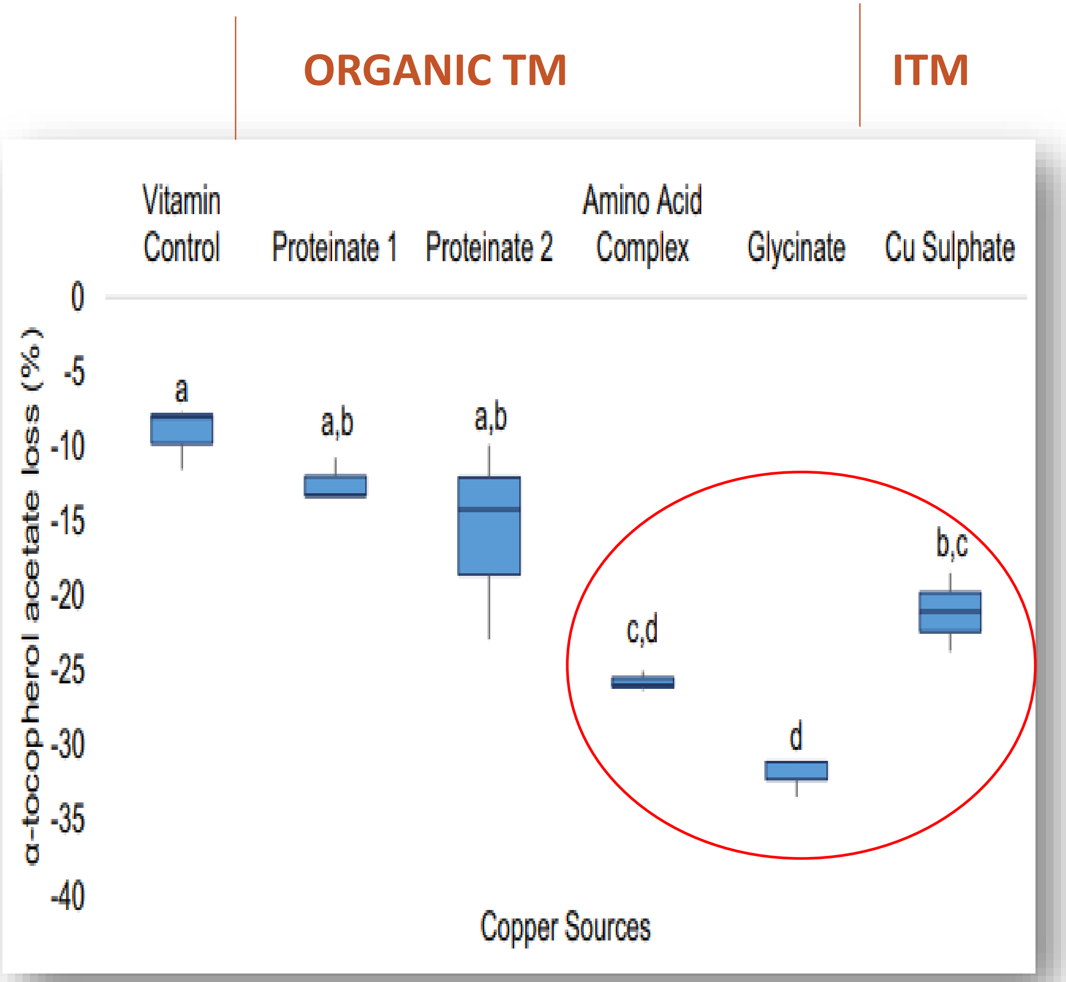
The effect of Cu sources on the stability of Vitamin E:

- The relationship between Vit E stability and Cu can be significantly impacted by Cu source
- Proteinate 1 and 2 did not significantly increase vIt e loss

HOWEVER

- The Cu amino acid complex, the Cu glycinate and the Cu sulfate were all found to significantly increase the level of Vit E loss (compared to the control)

The results of this study shows that source have a significant impact and that not ALL organic Cu sources increase Vit E preservation when compared to inorganic Cu sulfate



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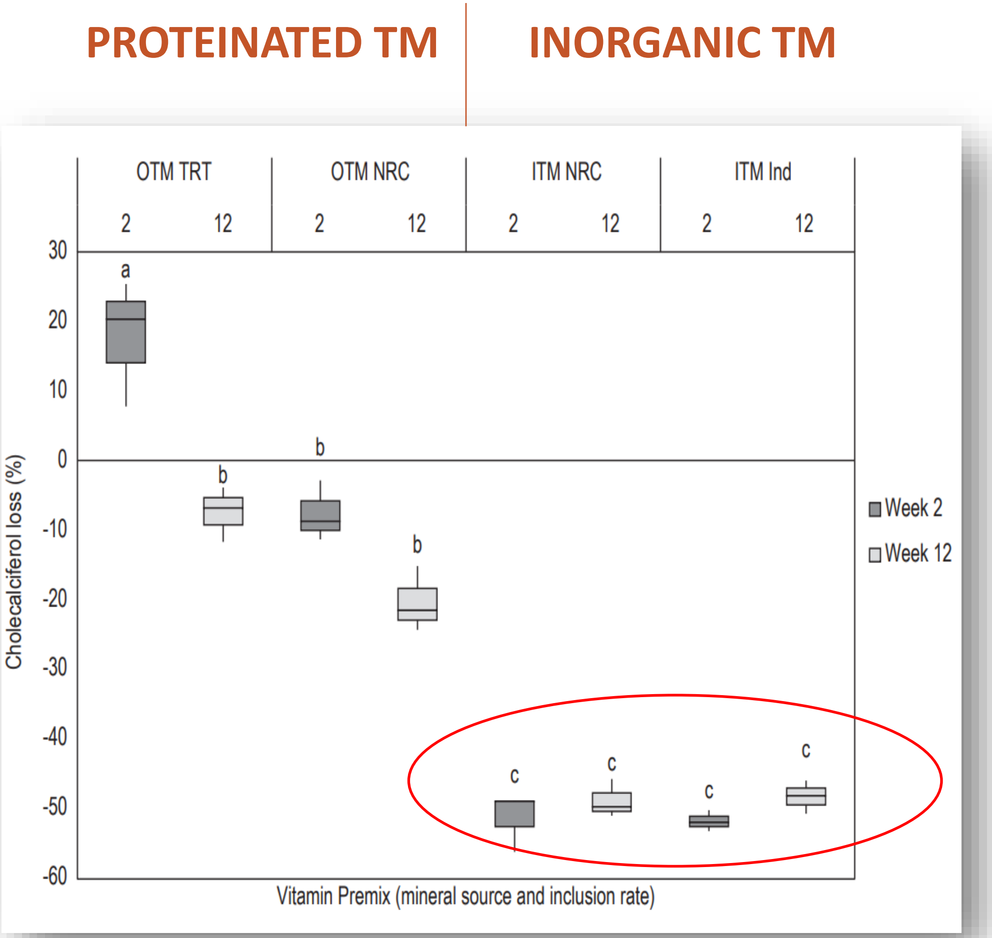
TRACE MINERALS AND PREMIX COMPONENTS - VITAMIN D (cholecalciferol)

Cholecalciferol loss in presence of premix containing Bioplex (TRT), Bioplex (NRC), Inorg (NRC) and Inorg (Industry):

Week 2:

- Bioplex (TRT) loss significantly lower (< 6%)
- Bioplex (NRC) loss of 7.67%
- ITM (NRC) loss of 51.46%
- ITM (Ind) loss of 51.9%



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TRACE MINERALS AND PREMIX COMPONENTS - VITAMIN A

Trace mineral source and inclusion rate on stability of retinol acetate:

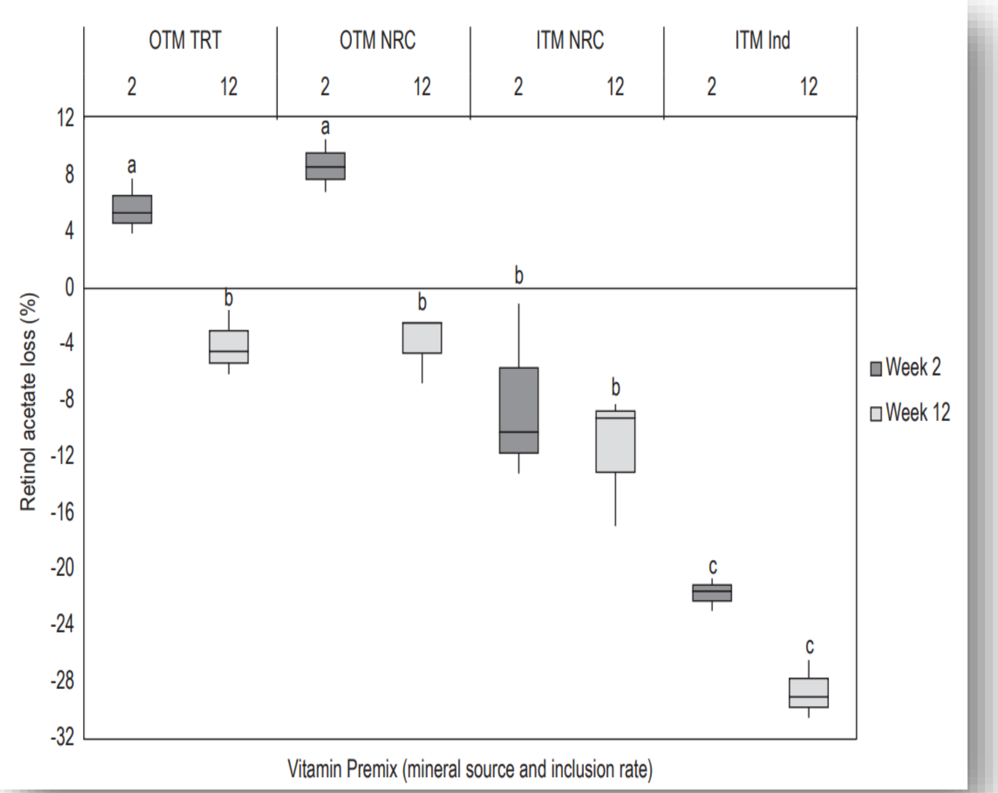
After 2 weeks:

- The premixes containing proteinates (Bioplex) had no negative impact on the stability of Vit A
- ITM (NRC) had a loss of 8.17% and
- ITM (Ind) a loss of 21.72%

After 12 weeks:

- Bioplex (TRT): 4.04%
- Bioplex (NRC): 3.88%
- ITM (NRC): 11.47%
- ITM (Ind): 28.7%

PROTEINATED TM | INORGANIC TM



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Interactions = Over fortification of Vitamins

Table 1. Effects of different mineral premixes on the storage stability of vitamins in broiler diet premixes[1]

Vitamin	Unit/kg	Calculated activity at day 0	Analyzed activity of MV1 after storage[2]	% MV1 activity of day 0	Analyzed activity of MV2 after storage[3]	% MV2 activity of day 0	% MV1 activity of MV2
A	IU	594000	23300	3.92	225000	37.88	10.36
D3	IU	165000	43800	26.55	86900	52.67	50.40
E	IU	1980	8.91	0.45	10.1	0.51	88.22
K	mg	118.8	3.21	2.70	52.5	44.19	6.11
Thiamin	mg	118.8	27.1	22.81	114	95.96	23.77
Riboflavin	mg	396	283	71.46	436	110.10	64.91
Pantothenic Acid	mg	660	659	99.85	675	102.27	97.63
Niacin	mg	2640	2490	94.32	2720	103.03	91.54
Pyridoxine	mg	237.6	112	47.14	176	74.07	63.64
Biotin	mg	6.6	6.42	97.27	7.99	121.06	80.35
Folic Acid	mg	79.2	18.7	23.61	56.2	70.96	33.27

[1]The vitamin mineral premix was analyzed following the animal trial after a total time of storage of 150 days.
[2]MV1: vitamins with inorganic mineral premix
[3]MV2: vitamins with organic mineral premix

INORGANICS vs PROTEINATES

- Vit A:34%
- D3: 26%
- Vit K: 41%
- Thiamin: 73%
- Niacin: 8%
- Biotin: 24%
- Folic Acid: 47%

Journal of Applied Animal Nutrition, Vol. 7; e6; page 1 of 5 doi:10.1017/jan.2019.4

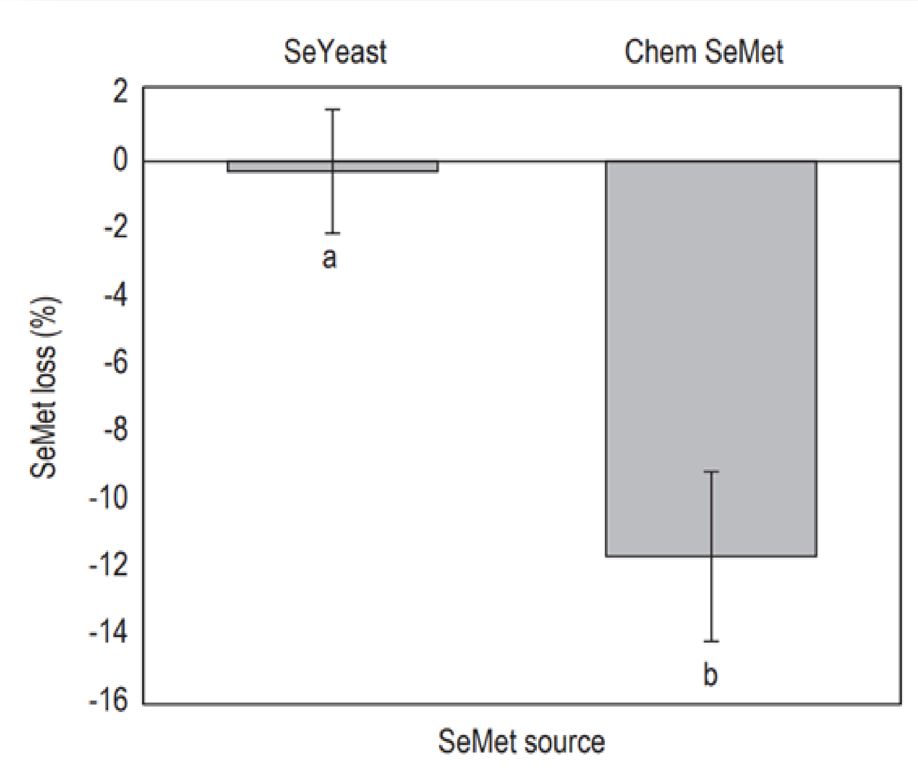
TRACE MINERALS AND PREMIX COMPONENTS - SELENIUM

The effect of a sulphate trace mineral source on the stability of two different organic selenium sources:

After 7 weeks:

- Sel-Plex: SeMet were only slightly decreased (0.29%)
- L-SeMet: exhibited a significant loss (11.7%)

The SeMet present as chemically synthesized L-SeMet elicited significantly higher (P<0.05) SeMet loss when compared to Sel-Plex (the se yeast source)



Concarr et al, JAAN 9 (1), 2021 (Bioplex-741 Concarr)

Trace Mineral Source:

Relative Bioavailability

Bioavailability of Trace Mineral Sources

- Trace mineral bioavailability is a measure of how much mineral is:
  - Digested
  - Absorbed
  - Used for biological functions

- There is a clear link between stability and Relative Bioavailability (RBV) of trace mineral sources

- Multiple research papers show proteinated organic trace minerals have increased bioavailability compared to inorganic and organic minerals

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Relative Bioavailability (RBV)

Table 4. Relative bioavailability of zinc sources in poultry (adapted)

Zn source	Zn indices	Relative bioavailability (%)	Reference
Zn sulfate (reagent grade)	Bone Zn	100	Cao *et al.*, 2000
Zn sulfate (basic)	Bone Zn	101	
Zn chloride (basic)	Bone Zn	107	
Zinc oxide (feed-grade)	Bone Zn	49	
Zn sulfate	Weight gain	100	Ao *et al.*, 2006
Zn proteinate	Weight gain	183	
Zn sulfate	Tibia Zn	100	Ao *et al.*, 2006
Zn proteinate	Tibia Zn	157	
Zn acetate	Mucosal MT	100	Cao *et al.*, 2002
Zn proteinate	Mucosal MT	99-130	
Zn methionine	Mucosal MT	77-94	
Zn sulfate	Weight gain	100	Batal *et al.*, 2001
TBZC	Weight gain	110	
Zn sulfate	Bone Zn	100	Cao *et al.*, 2000
Zn Aa chelate	Bone Zn	83-104	
Zn proteinate A	Bone Zn	116-139	
Zn sulfate	Mucosa Zn	100	Cao *et al.*, 2000
Zn Al chelate	Mucosa Zn	64-104	
Zn proteinate A	Mucosa Zn	65-133	
Zn sulfate	Bone Zn	100	Wedekind *et al.*, 1992
Zinc-methionine	Bone Zn	117-199	

There are clear differences between IOTM and OTM sources

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Trace Mineral Source:

Animal Health

TRACE MINERAL BENEFITS FOR PETS

Zn

ZINC
- Skin and coat health
- Immune support
- Growth and development
- Bone development

Mn

MANGANESE
- Supports metabolism
- Brain health
- Bone development
- Reproduction (breeding pets)

Se

SELENIUM
- Builds muscle strength
- Natural antioxidant effects
- Reproduction (breeding pets)
- Immunity

Cu

COPPER
- Supports immunity
- Healthy bones and heart
- Soft and shiny coat
- Skeletal development

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Trace Mineral Requirements

	NRC		AAFCO	
	Puppies	Adults	Growth and Reproduction	Adults
Zn	25 mg/1000 Kcal ME	15 mg/1000 Kcal ME	100 mg/kg DM	80 mg/kg DM
Fe	22 mg/1000 Kcal ME	7.5 mg/1000 Kcal ME	88 mg/kg DM	40 mg/kg DM
Cu	3.1 mg/1000 Kcal ME	1.5 mg/1000 Kcal ME	12.4 mg/kg DM	7.3 mg/ kg DM
Mn	1.4 mg/1000 Kcal ME	1.2 mg/1000 Kcal ME	7.2 mg/kg DM	5 mg/kg DM
Se	87.5 mcg/1000 Kcal ME	87.5 mcg/1000 Kcal ME	0.35 mg/kg DM	0.35 mg/kg DM

- Recommendations are based on simply meeting requirements
- No attention given to trace mineral form, stability and relative bioavailability

Organic trace minerals are more bioavailable

Inorganic trace minerals can inhibit enzyme, antioxidant and vitamin stability

Increase Lifespan?

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Oxidative Stress

- Many of most common diseases associated with aging (cognitive decline, atherosclerosis, osteoporosis and diabetes are related to low-grade inflammation
- Oxidative stress has a role in inflamm-aging, emphasizing the role of oxidative stress in in complex mechanism of aging
- Immune cells, which contain high levels of PUFAS in their plasma membranes, are thus highly sensitive to changes in the oxidant-antioxidant balance

Oxidative Stress and Older Animals

- Oxidative stress = cell and tissue damage = inflammation
- Inflammation is linked to disease incidence

Strategies to slow the pro-inflammatory state, including supplementation with antioxidants and vaccine optimization, can promote longevity

Antioxidants

- In Feed Antioxidants (Preservatives): ex BHT,BHA
- Omega-3-Fatty Acids
- Medium Chain Triglycerides (MCT)
- Micronutrients

Vitamins: Vitamins A, C and E

Trace Minerals: Fe, Zn, Mn, Cu and ***Selenium***

-

Organic Mineral Trials

Cats

Proteinated trace minerals and organic selenium yeast for Optimized Cat Health

CATS: Bone mineral density of cats fed different levels of trace elements (zinc, copper, iron, manganese and selenium) from organic and inorganic sources.

Mean (mmAl)

Bone	100% inorg	100% org*	80% org*	60% org*	40% org*	P-value	SEM	CV
Humerus	6,07	5,96	5,93	4,99	5,66	0,454	0,21	19,80
Radio	3,57	3,76	3,59	3,60	3,76	0,923	0,08	12,03
Ulna	3,88	3,95	3,93	3,71	3,99	0,869	0,09	12,28

**Bioplex Zn, Bioplex Cu, Bioplex Fe, Bioplex Mn, Sel-Plex*
SEM = standard error of mean, n=6 animals per treatment CV = coefficient of variation

TIME (weeks)

	1	4	8	12	16	20
Body weight (g)						
(100% inorganic)	926.20	1312.70	1731.40	2116.30	2465.80	2812.80
100% organic	919.10	1441.10	1847.50	2273.20	2698.50	3031.50
80% organic	915.80	1373.40	1896.50	2244.00	2602.20	2869.00
60% organic	919.43	1308.00	1689.29	2094.79	2422.00	2732.29
40% organic	**915.75**	**1353.42**	**1846.83**	**2212.08**	**2669.58**	**3038.17**
Body weight gain (g)						
(100% inorganic)	65.20	386.40	805.10	1190.00	1539.50	1886.50
100% organic	103.70	522.00	928.40	1354.10	1779.40	**2212.40**
80% organic	111.40	457.60	980.70	1328.20	1686.40	1953.20
60% organic	83.57	388.57	769.86	1175.36	1502.57	1812.86
40% organic	93.17	437.67	931.08	1296.33	1753.83	**2122.42**
Ration intake (g/week)						
(100% inorganic)	285.10	375.70	467.60	499.10	537.90	623.80
100% organic	284.20	423.80	478.10	498.60	589.00	610.50
80% organic	277.70	401.40	509.20	532.70	566.10	545.90
60% organic	272.00	350.50	448.79	474.21	503.43	553.36
40% organic	253.00	385.50	505.17	493.92	589.00	581.00

SEM = standard error of mean,
n=6 animals per treatment
CV = coefficient of variation

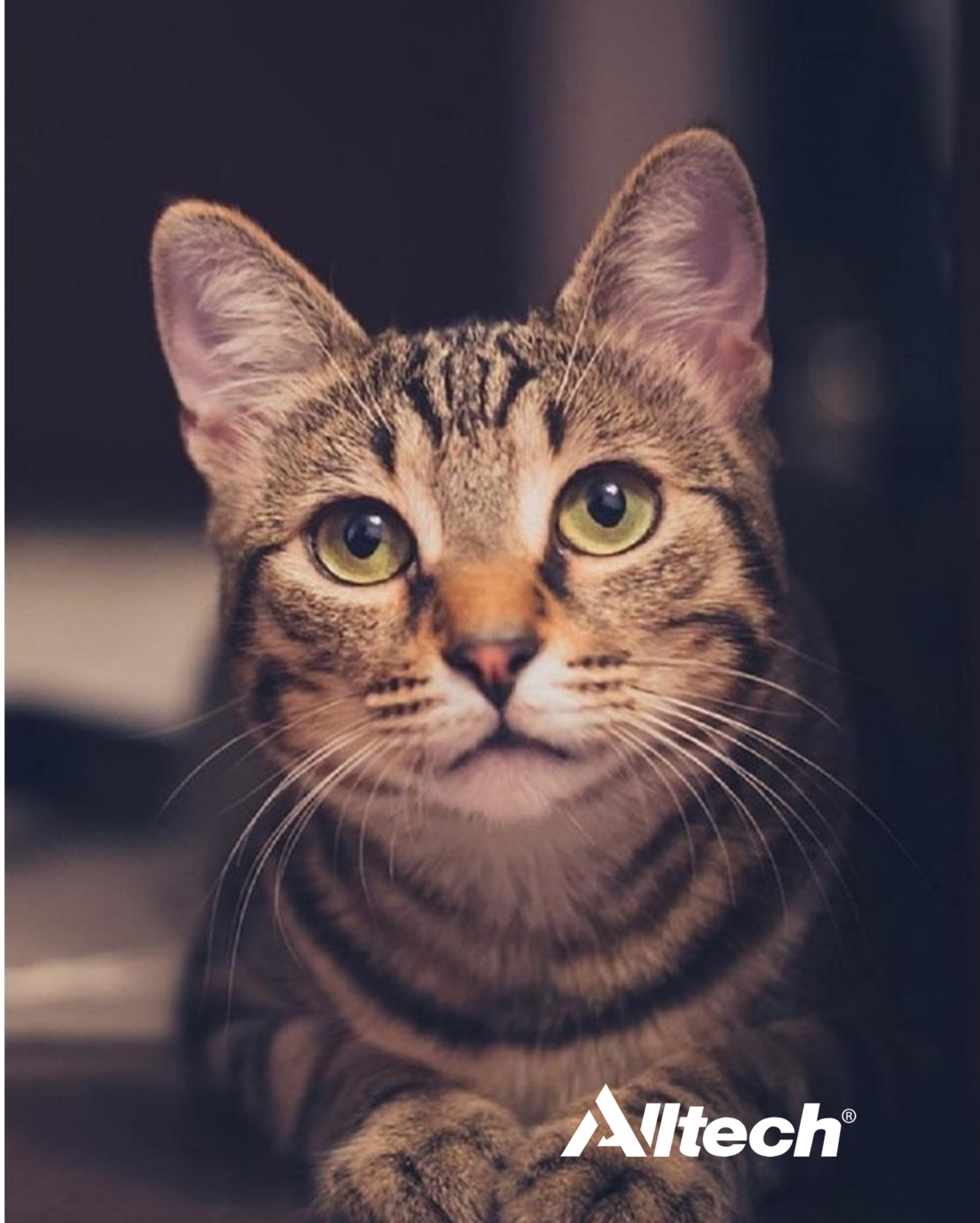
There were no significant differences among treatments, despite 40% less mineral added

	Time (days)		P-value	SEM	CV
	0	120			
Glutatione Peroxidase (nmol/min/mL)					
Control (100% inorganic)	5266,38	5841,66			
100% organic	5627,16	5577,14			
80% organic	5614,15	5269,90	0,841	108,59	14,44 60%
60% organic	4991,18	4940,93			
40% organic	5075,36	4983,86			
Superoxide Dismutase (U/ml)					
Control (100% inorganic)	8,05	6,14			
100% organic	6,94	6,23			
80% organic	6,44	4,84	0,674	0,38	42,81
60% organic	7,65	3,80			
40% organic	8,02	4,61			
TBARS (µM)					
Control (100% inorganic)	5,08	3,55			
100% organic	4,68	2,67			
80% organic	4,90	3,66	0,738	0,22	37,06
60% organic	4,74	3,07			
40% organic	5,20	3,74			

	Time (days)						
	0	40	80	120	P-value	SEM	CV
Hair growth (g/24.5cm²)							
(100% inorgânic)	0,24	0,32	0,31	0,19	0,804	0,01	38,9
100% organic	0,25	0,26	0,35	0,21			
80% organic	0,23	0,37	0,32	0,18			
60% organic	0,25	0,28	0,33	0,22			
40% organic	0,19	0,43	0,39	0,20			
Sieve height (cm)							
(100% inorganic)	17,70	21,66	23,32	25,69	0,804	0,29	14,14
100% organic	17,83	22,30	23,97	26,13			
80% organic	18,23	21,73	23,67	26,16			
60% organic	17,36	21,63	23,68	25,65			
40% organic	17,88	21,95	24,14	25,71			
Body length (cm)							
100% inorganic	42,81	53,82	58,67	62,40	0,861	0,70	14,19
100% organic	43,03	55,16	58,24	61,40			
80% organic	42,93	52,19	58,56	61,56			
60% organic	42,25	51,66	57,83	61,11			
40% organic	42,22	53,42	59,29	61,01			

CONCLUSION

- Based on these results, we can replace inorganic minerals with Bioplex at **40 percent** of the NRC (2006) recommendations.
- Results support the health benefits of a trace mineral program with lower inclusion rates for pets.



Organic Mineral Trials

Dogs

Proteinated trace minerals and Organic selenium yeast for Optimized Growth in Puppies

Method

- Twenty-four weaned puppies
  - Extruded dry feed diet

Dietary treatments

1) **100% ING (inorganic)** – 100% of supplementation recommended by the NRC (2006)
2) **100% ORG (BIOPLEX®, Alltech Inc.)** – 100% of supplementation recommended by the NRC
3) **70% ORG** –70% of supplementation recommended by the NRC
4) **40% ORG** – 40% of supplementation recommended by the NRC

**NRC; National Research Council, 2006*

Inorganic trace minerals were provided in the form of sulphates
Organic trace minerals were provided in the form of BIOPLEX Cu, Fe, Mn and Zn, and SEL-PLEX® organic selenium-enriched yeast

Results – enzyme activity

40% organic trace minerals maintained optimal enzymatic levels

Item	100% ING	100% ORG	70% ORG	40% ORG	P-value	EPM
SOD (U/mL)	4.91	4.54	4.40	**5.44**	0.49	0.49
GPx (nmol/min/mL)	5757	5710	5693	**5663**	0.35	17.51
MDA (µM)	18.00	19.30	17.91	**18.10**	0.97	2.52

Results – mineral retention

Puppies supplemented with 40% and 70% proteinated organic minerals had:

- **Higher skin retention**
- **Lower excretion of dietary trace mineral**

Skin retention (mg/kg)

Mineral	100% ING	Supplementary levels (ORG)			P-value
		100%	70%	40%	
Fe	302.66[a]	110.75[a]	534.42[b]	327.66[a]	0.00
Cu	1.27[a]	1.52[a]	1.89[a]	4.77[b]	0.01
Mn	29.13	11.77	40.76	31.66	0.07
Zn	183.86	119.07	207.19	184.48	0.21
Se	0.92	0.60	1.36	0.99	0.18

Dietary mineral excretion (mg/kg/day)

Mineral	100% ING	Supplementary levels (ORG)			P-value
		100%	70%	40%	
Fe					
Feces	97.82	71.61	94.19	79.00	0.46
Urine	0.14	0.11	LQ	0.22	0.15
Cu					
Feces	8.32[a]	8.55[a]	6.76[b]	6.18[b]	0.02
Urine	0.06	LQ	0.02	0.06	0.42
Mn					
Feces	24.25	24.43	21.02	21.13	0.50
Urine	0.14	0.11	LQ	0.22	0.15
Zn					
Feces	41.16	40.62	38.80	40.06	0.98
Urine	1.12	0.47	LQ	0.41	0.26
Se					
Feces	0.81	0.77	0.75	0.73	0.86
Urine	0.34[a]	0.17[b]	LQc	0.12[b]	0.00

Results – mineral bone density

70% of proteinated org minerals presented the highest mineral density (P<0.05)

Item	100% ING	Supplementary levels			P-value	EPM
		100% ORG	70% ORG	40% ORG		
Humerus	1.93[b]	1.95[b]	**2.84[a]**	2.11[b]	0.01	0.19
Radius	1.78[b]	1.89[b]	**2.81[a]**	2.09[b]	0.04	0.24
Ulna	1.81[b]	1.75[b]	**2.79[a]**	1.83[b]	0.01	0.22

Results – growth

Item	Times (weeks)	100% ING	Supplementary levels			P-value	EPM
			100% ORG	70% ORG	40% ORG		
Weight (kg)	0	1.29	1.29	1.31	1.28	1.00	0.16
	3	1.63	1.75	1.8	1.84	0.86	0.18
	6	2.38	2.48	2.79	2.87	0.46	0.25
	9	3.76	3.85	4.09	4.46	0.56	0.38
	12	5.67	5.60	5.66	6.79	0.35	0.51
	15	7.97	7.74	7.89	9.58	0.23	0.67
	18	9.71	9.45	9.67	11.15	0.50	0.83

By the end of the trial:

- Puppies fed 40% proteinated organic trace minerals achieved the highest body weight (11.15 kg)

Conclusion

- Feeding proteinated organic trace minerals as low as 40% of NRC recommendations for inorganic levels did not negatively affect growth performance and enzymatic activity.
- 70% can be indicated for diets with specific function for hair and skin, as there was greater deposition and better utilization of the minerals in these tissues.

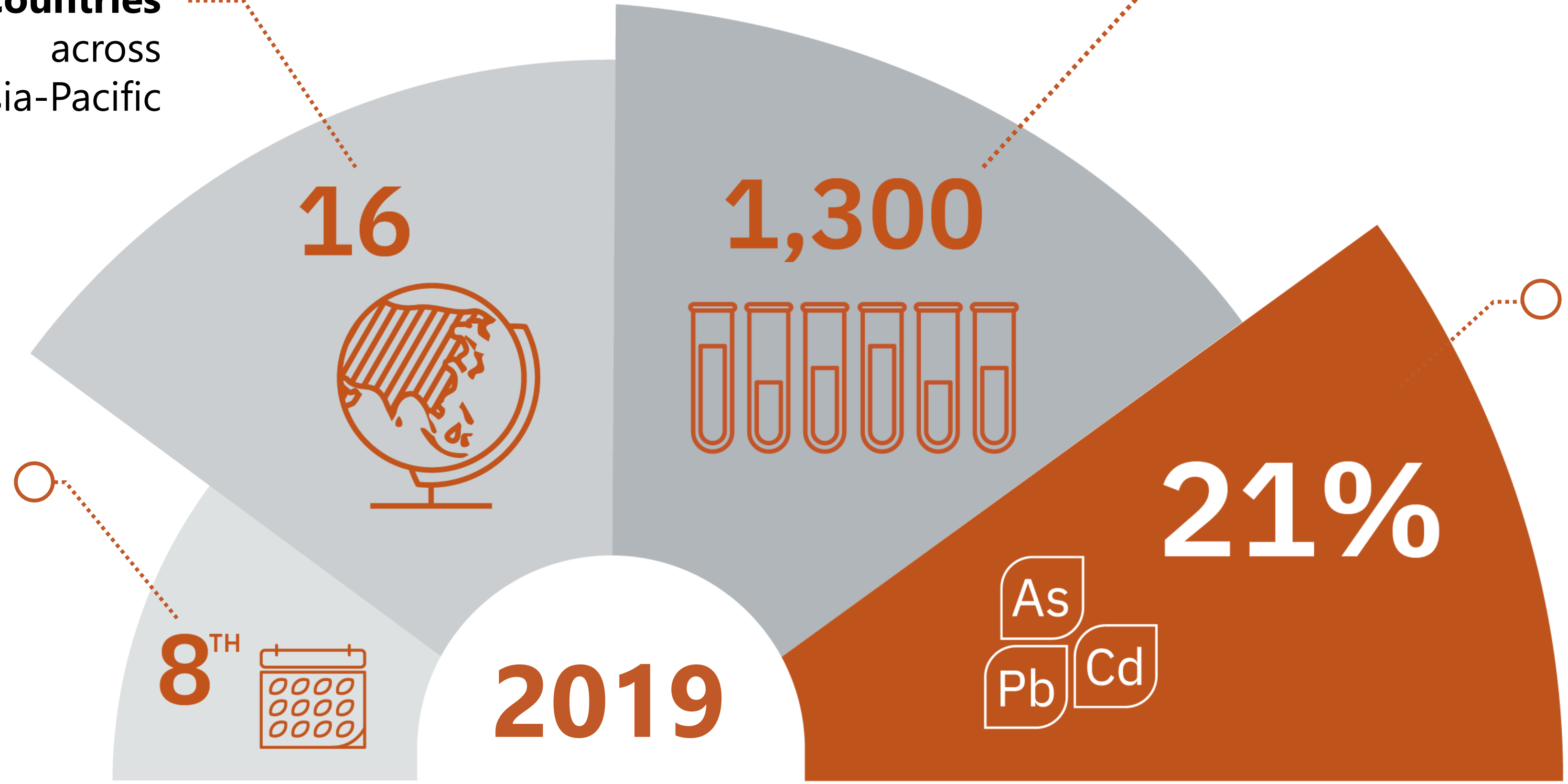
The results of this trial demonstrate that organic trace mineral proteinates can be fed to growing dogs at much lower levels and maintain growth and metabolism.

Quality Control

QUALITY CONTROL: DO YOU KNOW WHERE YOUR MINERALS COME FROM?

Countries across Asia-Pacific

Samples have been included in **analysis**



Year of conducting HM survey

Of **samples tested** were contaminated with at least one heavy metal above EU levels for **Arsenic, Cadmium and Lead**

To continue to highlight risks associated with trace mineral sources in the feed industry

Global Survey Publication: Elliott et al., JAAN 5:8, 2018 (**Bioplex-613/Elliott2017A**)

BRAND A

Chicken, Brewers Rice, Yellow Peas, Cracked Pearled Barley, Whole Grain Oats, Whole Grain Corn, Egg Product, Chicken Fat, Corn Gluten Meal, Chicken Liver Flavor, Pork Liver Flavor, Soybean Oil, Flaxseed, Lactic Acid, L-Lysine, Potassium Chloride, Calcium Carbonate, Dicalcium Phosphate, Carrots, Dried Tomato Pomace, Dried Citrus Pulp, Spinach, Fish Oil, Iodized Salt, vitamins (Vitamin E Supplement, L-Ascorbyl-2-Polyphosphate (source of Vitamin C), Niacin Supplement, Thiamine Mononitrate, Vitamin A Supplement, Calcium Pantothenate, Riboflavin Supplement, Biotin, Vitamin B12 Supplement, Pyridoxine Hydrochloride, Folic Acid, Vitamin D3 Supplement), Lipoic Acid, Choline Chloride, Taurine, minerals (Ferrous Sulfate, Zinc Oxide, Copper Sulfate, Manganous Oxide, Calcium Iodate, Sodium Selenite), Natural Flavors, Mixed Tocopherols for freshness, L-Tryptophan, L-Carnitine, Beta-Carotene.

Guaranteed Analysis	
CRUDE PROTEIN	19.0% min
CRUDE FAT	11.0% min
CRUDE FIBER	3.0% max
MOISTURE	10.0% max
LINOLEIC ACID	1.3% min
VITAMIN E	450 IU/kg min
ASCORBIC ACID	85 mg/kg min
OMEGA-3 FATTY ACIDS	0.4% min
OMEGA-6 FATTY ACIDS	1.7% min

BRAND B

Chicken, chicken meal, brown rice, barley, oatmeal, natural turkey and chicken flavor, dried plain beet pulp, chicken fat (preserved with tocopherols and citric acid), flax seeds, menhaden fish meal (a source of fish oil), dried egg product, brewers dried yeast, potassium chloride, DL methionine, salt, minerals (zinc proteinate, iron proteinate, copper proteinate, manganese proteinate, selenium yeast), choline chloride, vitamins (vitamin A acetate, vitamin D3 supplement, vitamin E supplement, niacin, d-calcium pantothenate, thiamine mononitrate, pyridoxine hydrochloride, riboflavin supplement, folic acid, biotin, vitamin B12 supplement), glucosamine hydrochloride, lactic acid, L-ascorbyl-2-polyphosphate (source of vitamin C), chondroitin sulfate, yucca schidigera extract, taurine, L-carnitine, calcium iodate, rosemary extract, yeast culture, dried Lactobacillus acidophilus fermentation product, dried Enterococcus faecium fermentation product, dried Aspergillus oryzae fermentation extract, dried Trichoderma longibrachiatum fermentation extract, dried Bacillus subtilis fermentation extract.

Guaranteed Analysis

Nutrient	Guaranteed Units
Crude Protein	26% min
Crude Fat	10% min
Crude Fiber	5.5% max
Moisture	10% max
Iron	120 mg/kg min
Copper	10 mg/kg min
Manganese	11 mg/kg min
Zinc	160 mg/kg min
Selenium	0.35 mg/kg min
Vitamin E	155 IU/kg min
Omega-6 Fatty Acids	1.8% min
Omega-3 Fatty Acids	0.5% min
Glucosamine	300 mg/kg min

- Pets need trace minerals for optimum growth and development
- As animals age they exhibit an elevation of serum concentration of oxidative damage biomarker, indicating that they have a reduced ability to respond to oxidative stress.
- The implementation of strategies to slow pro-inflammatory state, such as suppl with antioxidants seems to be essential to promote a long and healthy lifespan BUT ingredient SOURCE can impact overall dietary efficacy

Alltech®

PREVENTION versus TREATMENT?

- Requirements: Maintenance vs Optimized Immunity
- “Healthspan versus lifespan”
- Prevention: Focus on all life stages

Conclusion

Trace Mineral Source will

- Impact stability of essential nutrients within premix and complete feed (impact shelf life and claims)
- Relative Bioavailability are impacted by trace mineral source
- Animal health depend on balance and efficacy of all micronutrients (balance), availability and utilization

Holistic approach for an optimized immune response

ASK FOR PRODUCT SPECIFIC RESEARCH and RECOMMENDATIONS