THOMSON & JOSEPH LTD

The Mineral Specialists

NOVUS
SOLUTIONS SERVICE SUSTAINABILITY

PROTECTED MINERALS

Protected minerals are today a common feature of the feed additive market. Although many different products are being promoted, they can broadly be placed in one of four categories:

> **Metal Amino Acid Chelates (MAAC)**
Novus (Albion)
> **Metal Proteinates**
Alltech, Optimins, Key Minerals
> **Metal Amino Acid Complexes**
Zinpro
> **Metal Polysaccharide Complexes**
Qualitech

Indeed, these are the categories used by the American Association of Feed Control Officials (AAFCO) to differentiate between the many products in the market place. In the EU the situation is different in that each product has to receive separate approval for inclusion on a positive list for each trace element.

The American system in many respects is easier to follow, as it categorises protected minerals in terms of their chemistry, for example:

Metal Amino Acid Chelates (MAAC)

Mineral ions chelated to amino acids within a ratio of 1 to 3 amino acids to each mineral ion. Molecular Weight to be no more than 850 daltons. Includes Glycine MAACs.

Metal Proteinates

Mineral ions attached with amino acids and peptides, with no restriction on the ratio of amino acids to mineral ions and no limit on Molecular Weight. Clearly a much larger molecule than MAACs.

Metal Amino Acid Complexes

A mineral ion attached to one amino acid. As not all bonds of the divalent mineral ion are involved in the attachment process, the complex remains ionised, i.e. Zinc Methionine ⊕ balanced by an anion hydrogen sulphate ⊖

Metal Polysaccharide Complexes

Mineral ions attached to polysaccharide molecules of nondescript composition and size.

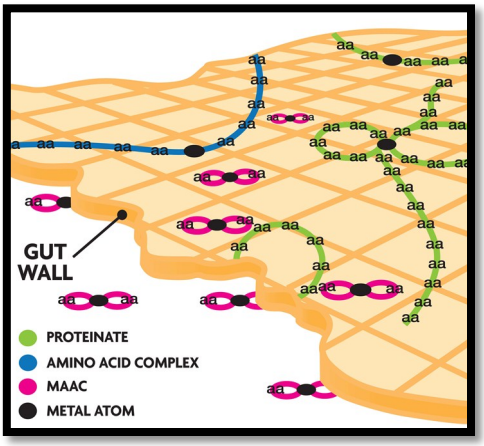
How Metal Amino Acid Chelates compare with other "protected" minerals

Product (AAFCO Definition)	Metal Amino Acid Chelates	Metal Proteinates	Metal Poly-saccharide Complexes	Metal Amino Acid Complexes
Has it a chelate structure?	YES	NO	NO	NO
Is it stable in GI tract?	YES	NO	NO	NO
Is it absorbed intact?	YES	NO	NO	NO
Has it a physio-logical role post -absorption?	YES	NO	NO	NO
What is the molecular weight?	<800	HIGH	HIGH	LOW
Anion contaminations sulphate, chloride?	LOW	HIGH	HIGH	HIGH
BRAND NAME:	Novus MAAC	BIOPLEX	CARBOSAN	ZINPRO

Of all the four categories, Novus MAAC are the *only* products to satisfy the criteria:

> Complete chelation
> Defined molecular structure
> Limit on molecular weight
> Electronically neutral, all chemical bonds satisfied
> Total mineral protection

MAAC are absorbed intact across the gut wall unlike Proteinates and Polysaccharide Complexes which have to be broken down before they can be absorbed.

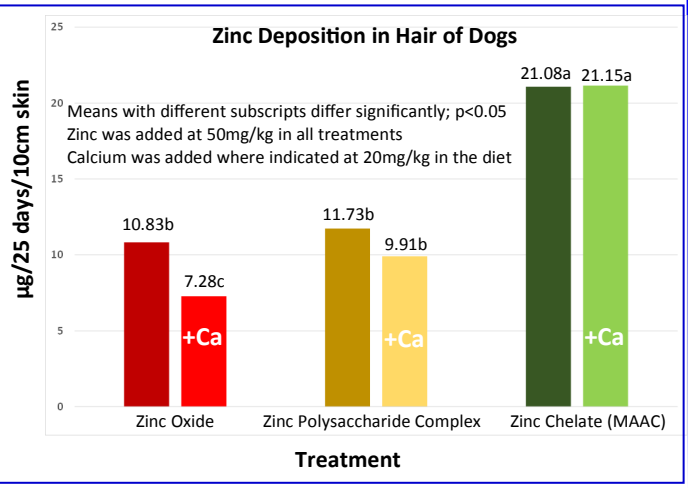


A number of trials have been conducted to compare the relative efficacy of products from the four different protected categories.

TRIALS— Evaluation of Zinc Metal Amino Acid Chelate in Dogs

Zinc is an essential micronutrient for dogs, with a particular requirement for skin health and hair growth.

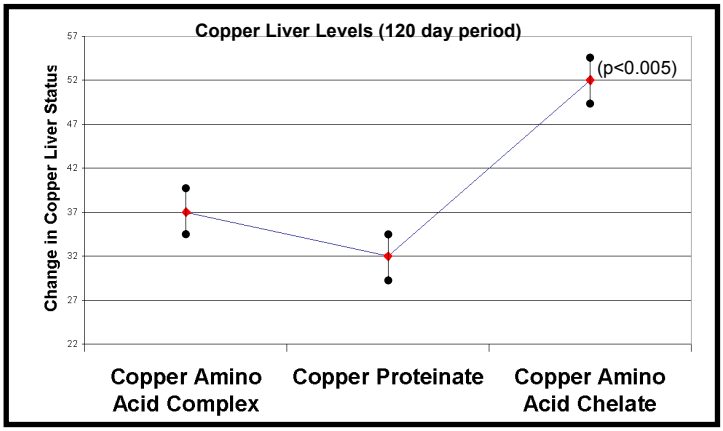
In a trial undertaken at the University of Nottingham by John Lowe (1998), dogs received one of three Zinc sources: Zinc Oxide, Zinc Polysaccharide Complex and Zinc MAAC at a dietary level of 50mg/kg. Each dietary treatment was split to include a "with" and "without" option of 2% Calcium; this representing a well known suppressor of Zinc absorption. Efficacy of Zinc source and treatment was measured in terms of Zinc retained in hair over a 25 day period taken from replicated 10cm strips. The results are presented below. They show a similar level of Zinc retention for the Zinc Oxide and Zinc Polysaccharide Complex treatments, with a marked depression when 2% Calcium was included in the diet. This observation is in marked contrast to Zinc MAAC, which reported a significantly higher level of retention, being X2 higher than the other treatments.



1. Ref: Lowe, J.A. et al (1998)

Furthermore, the imposition of 2% Calcium had no effect on Zinc retention, which suggests a high degree of protection for the Zinc Chelate from the depressive effects of Calcium in the digestive tract.

TRIALS— Comparison of Organic Copper Supplements in Angus Steers Fed Copper Antagonists



The liver is a key storage site for Copper. Consequently changes in the liver retention of Copper can be used as an indicator of the comparative availability of different Copper sources. In this trial, 27 Angus steers (avg 318kg l.wt) were assigned to a grass hay, high moisture corn and protein concentrate diet to which was added one of three Copper sources: Copper Amino Acid Complex, Copper Proteinate and Copper MAAC at a dietary level of 20mg/kg. Cattle were allocated to a Copper dietary treatment on the basis of a pre-trial liver biopsy to ensure initial mean liver Copper levels were the same across all treatments. The trial was conducted for 120 days, during which time all diets fed contained a high level of Copper antagonists, 10mg/kg Molybdenum, 750mg/kg Iron and 0.35% Sulphur. Liver biopsies were carried out at the end of the 120 day trial.

Results showed the change in liver Copper level was significantly higher ($p<0.005$) for the Copper MAAC compared to the Proteinate and Amino Acid Complex treatments. These latter two Copper sources were not significantly different in terms of Copper liver retention.

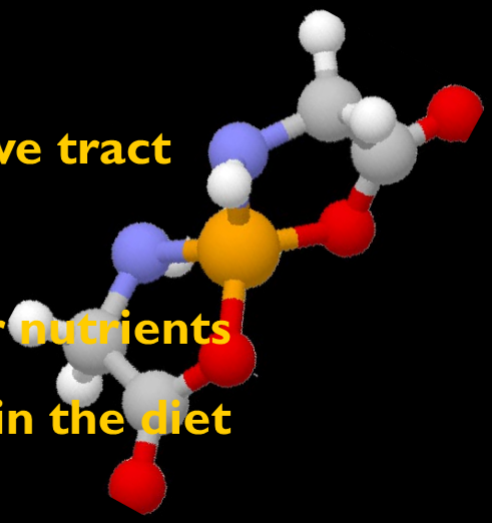
From this evaluation, it is clear that the comparative availability from Copper MAAC is over 50% higher than that reported from the Copper Proteinate and the Copper Metal Amino Acid Complex treatments.

2. Ref: Ashmead, H.D. et al (2004)

MAAC Features

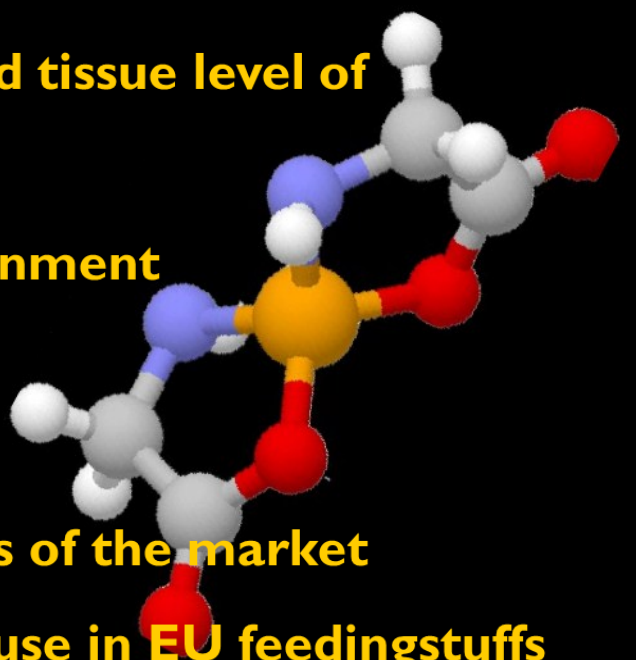
EU permitted feed additive

- Protected mineral structure
- Stable through rumen and digestive tract
- Improved retention
- No adverse interaction with other nutrients
- Overcomes mineral antagonisms in the diet
- GMO free



MAAC Benefits

- High mineral availability
- Absorbed intact with increased tissue level of minerals
- Reduced excretion into environment
- Does not degrade vitamins
- Stimulates fertility and health
- Meets GMO free requirements of the market
- MAAC - legally permitted for use in EU feedingstuffs



The Available Mineral Option for Farm Livestock

REFERENCES—

1. A Comparison of the Bioavailability of Three Dietary Zinc Sources Using Four Different Physiologic Parameters in Dogs. Lowe, J.A. and Wiseman, J. J. Nutr. (1998) 128, 2809S.

2. The Effects of Dietary Molybdenum, Sulphur and Iron on Absorption of Three Organic Copper Sources. Ashmead, H.D. and Ashmead, S. D. J. Applied Red in vet Medicine (2004). Vol 2. No. 1, 1-9.