THOMSON & JOSEPH LTD

The Mineral Specialists

NOVUS
SOLUTIONS SERVICE SUSTAINABILITY

NOVUS MAAC GLYCINE CHELATES

In 2010 Novus purchased Albion's Animal Nutrition Division to add Albion's Metal Amino Acid Chelates (MAAC) to their range of feed additives for ruminant livestock. Novus are the world's largest manufacturer of methionine for pigs and poultry, and purchased Albion's MAAC animal products as part of their plans to expand into the ruminant nutrition market.

Novus has replaced Albion as the prefix for MAAC, however, the same Albion plant in the US continues to manufacture the MAAC Glycine Chelate range of nutritional feed additives.

In 2008, Albion were the first company to launch a new generation of Metal Amino Acid Chelates (MAAC) using Glycine as the chelating amino acid. Previously a mixture of amino acids derived from hydrolysed soya protein had been used as the chelating agents.

Glycine is a naturally occurring amino acid with the lowest molecular weight. The use of Glycine enables a stable, low molecular weight molecule to be produced with a defined structure which can be measured quantitatively.

SO WHY GLYCINE?

> Precisely defined molecule.

> Lower molecular weight.

> Higher mineral concentration.

> Unit cost of mineral is lower.

> Quantitative Method of Analysis has been developed.

> Trial work available.

> EU Registration obtained.

> Albion had already developed Glycine chelates for human use.

GLYCINE BENEFITS

The benefits of Glycine chelates are...

> Smaller molecule results in slightly better absorption compared to soya hydrolysate chelates.

> Precise molecular structure enables the chelate to be analysed quantitatively, including the degree of chelation.

> Higher mineral level results in lower inclusion rates and reduced unit costs.

> Better meets the criteria of the EU Feed Additive Registration.

EU FEED ADDITIVE REGISTRATION

Novus have approval under EU Regulation—479/2006 to supply:

> Copper Glycine Chelate

> Iron Glycine Chelate

> Manganese Glycine Chelate

> Zinc Glycine Chelate

The regulatory criteria to use this registration include:

> Food grade Glycine must be used.

> Proof that Glycine is chelated to the mineral.

> Molar ratio of 1-3 moles of Glycine to 1 mole of metal.

> Example of Regulatory definition—"cupric chelate of glycine hydrate".

Novus are the only company to hold EU Feed Additive registrations for their Glycine chelates.

TRIALS— Glycine Chelates Improve Ovarian Activity & Uterine Health

The goal of a 15-month study at the University of Maryland was to determine the relationship between MAAC chelated trace minerals and several reproductive parameters including uterine health and involution, ovarian activity, early embryonic mortality, and breeding and conception rates.

Forty first-calf heifers were fed a control diet with Inorganic Trace Elements, the standard diet plus MAAC for 30 days prior to calving, or the standard diet plus MAAC from calving to breeding. The animals supplemented with MAAC showed improved uterine involution after calf delivery, decreased incidence of early embryonic death, earlier development of preovulatory follicles, and reduction in uterine scarring and bacterial infections.

Production responses for cows fed commercial levels of Zn, Cu and Mn as Inorganic Trace Elements or MAAC

Measurement	Control	MAAC	Difference
Ovarian Activity			
Mature follicles 30-80d post partum, %	20	35	+75%
Days to first F3 follicle	78	68	-13%
Infections			
Bacteria isolated from uterus, %	25	5	-80%
Early embryonic death, %			
"Repeat breeders"	20	0	-100%
Post-partum uterus involution			
Indistinguishable	50-55d	30-35d	-35/40%
Incidence of endometrial scarring, %	58	10	-83%

1. Ref: Manspeaker, J.A. and Robl, M.G. (1984)

TRIALS— Glycine Chelates Support Dairy Cow Fertility

A field trial involving 182 multiparous Holstein dairy cows from 8 different farms from the Brittany area of France was designed to compare the effects of Copper, Zinc and Manganese Glycine Chelates (MAAC) against Copper, Zinc and Manganese inorganic salts on reproductive performance. Herds involved in this study reported mean milk production ranging from between 8000-9000kg/cow/year.

Each farm had equal numbers of cows in each treatment group. Cows in each group started to receive 50g per day of an isomineral formulation containing either Glycine Chelates or Inorganic Salts, following calving and continuing for the first 120 days of lactation. This supplement provided an additional 300mg Zinc, 240mg Manganese and 150mg Copper daily allowance.

Effect of Copper, Zinc and Manganese Glycine Chelates on dairy cow fertility on 8 farms in Brittany (2006).

	Inorganic Mineral Group	Glycine Chelate Group	Difference
Mean services per conception	1.90	1.50	-21% ✓
First service pregnancy rate %	53	66	+25% ✓
Total pregnancy rate %	87	96	+10% ✓

2. Ref: Bosseboeuf, Y. et al (2006)

RESULTS

Even though MAAC Glycine Chelates were only fed for the first 120 days of lactation, reproduction data was recorded over the whole lactation period. Results include:

> Mean Services per Conception were significantly reduced in the MAAC group by 21% from 1.90 to 1.50 ($p<0.001$).

> Ist Service Pregnancy Rate was 25% higher on MAAC, increasing from 53 to 66% ($p<0.05$).

> Total Pregnancy Rate measured over the complete lactation period was up from 87 to 96% ($p<0.05$).

> The 100 day standardised milk production reported small and non-significant changes in yield and quality, however, the MAAC group did show a 2% increase in fat yield and 4.2% increase in protein yield.

> Cost Effective Ratio of 8.5:1 in favour of the MAAC treatment followed from the significant improvement in fertility and the less pronounced rise in milk fat and protein yield.

> The MAAC Glycine Chelate range has demonstrated its capability against the same daily intakes of minerals from inorganic salts to significantly and cost effectively improve dairy cow fertility.

TRIALS—Glycine Chelates Increase Milk Production and Fertility

First calf heifers are still growing throughout their first lactation and as a result have higher mineral requirements compared to mature cows.

This trial was carried out on 2 groups of Holstein first-calf heifers (25 per group) which were assigned to either an inorganic or MAAC Glycine Chelate group at calving.

Both groups received an identical daily mineral intake which from calving to 90 days into lactation was 180mg Copper, 360mg Manganese and 730mg Zinc. From 91 to 180 days the daily mineral intake was 127mg Copper, 255mg Manganese and 511mg Zinc.

Results—Milk Yield and Quality

Over the course of the heifer lactation..

> Mean daily milk production increased by 1.7 litres/cow (5.2%) on the MAAC treatment (p<0.01).

Milk Yield and Constituent Data

Group	Mean Total 305 Day Production	Mean Production / Day (kg)	Mean Fat %	Mean Total Fat (kg)	Mean Protein %	Mean Total Protein (kg)
Inorganic Mineral Group	10,026 ± 1453 [a]	32.9[a]	3.57 ± 0.48	355 ± 46.0[a]	3.01 ±0.21	301.2 ± 40.7[c]
Glycine Chelate Group	10,546 ± 910[b]	34.6[b]	3.76 ± 0.35	388 ± 46.9[b]	3.09 ± 0.17	325.7 ± 29.8[d]
% Difference	+ 5.2%	+ 5.2%	+ 5.3%	+ 9.3%	+ 2.7%	+ 8.1%

[ab] *Significant difference at p<0.01*

[cd] *Significant difference at p<0.05*

> % Fat and % Protein values also increased on the Chelate treatment by 5.3 and 2.7% respectively.

> Combining yield and quality improvements on MAAC resulted in an increased Fat Yield of +9.3% and Protein Yield of +8.1% (p<0.01).

Results—Reproduction

MAAC Glycine Chelates had a significant impact on fertility..

> Open Days from Calving to oestrus were reduced by 42 days (P<0.01).

> Mean Services per Conception dropped from 2.58 to 1.50; a 42% improvement (p<0.01).

> Early Embryonic Mortality together with the incidence of Cystitis and Metritis were also reduced.

> A rapid reduction in Uterine Horn Size post-calving is important to ensuring a successful re-breeding. At 7 weeks post-calving, the MAAC treatment showed a 6% reduction in Uterine Horn Size.

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

Reproductive Data

Group	Open Days Calving to Oestrus	Services Per Conception	Early Embryonic Mortality	Cystitis	Metritis	Uterine Horn Size 7 Weeks Post Calving
Inorganic Mineral Group	131 [a]	2.58[a]	5 (21%)[c]	11 (46%)[e]	6 (25%)[c]	33.7mm
Glycine Chelate Group	89[b]	1.50[b]	1 (5%)[d]	8 (36%)[f]	4 (18%)[d]	31.6mm
% Difference	-31.8%	-41.9%	-76.2%	- 21.7%	- 28.0%	- 6.23%

[ab] *Significant difference at p<0.01*

[cd] *Significant difference at p<0.05*

[ef] *Significant difference at p<0.10*

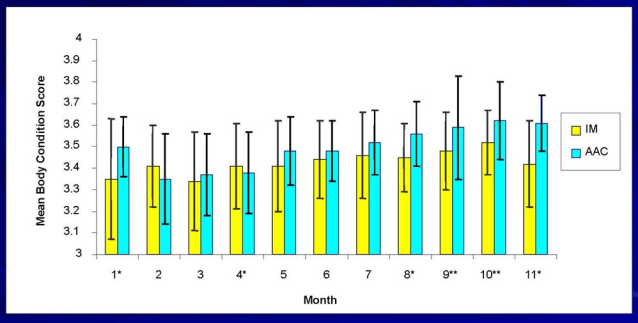
Results—Body Condition Score

MAAC Glycine Chelates also had an impact on improving cow body condition..

> Between calving and the 4th month into lactation there was no difference in body condition scores between treatments.

> From month 5, Body condition Scores on the MAAC treatment were higher than for the comparable inorganic mineral treatment.

Mean Monthly Body Condition Scores
Inorganic Mineral Versus Amino Acid Chelate



* Significant Difference at p<0.05

** P<0.10

> Between Months 5 and 12 MAAC heifers improved body condition scores by +0.2 from 3.5 to 3.7, compared to inorganic mineral heifers which showed no change from index 3.4 over this period. These differences were highly significant ($p<0.05$).

4. Ref. Ashmead, H.D. and Samford, R.A. (2004)

Results—Summary

MAAC Glycine chelates have showed in a properly replicated heifer trial and where equivalent levels of inorganic minerals were being fed to significantly..

> Raise milk yields and quality.

> Improve fertility parameters.

> Increase body condition scores.

These results demonstrate the capability of the MAAC Glycine Chelate range to improve mineral absorption to the benefit of energy utilisation and other mineral dependent processes.

GLYCINE CHELATE ANALYSIS— SHOW ME THE BONDS!

One of the key features of obtaining EU Feed Additive registration is to have a specific method of analysis for the additive undergoing approval. Albion have developed a method of analysis for Glycine chelates which answers the key questions—

Is my feed additive a chelate?

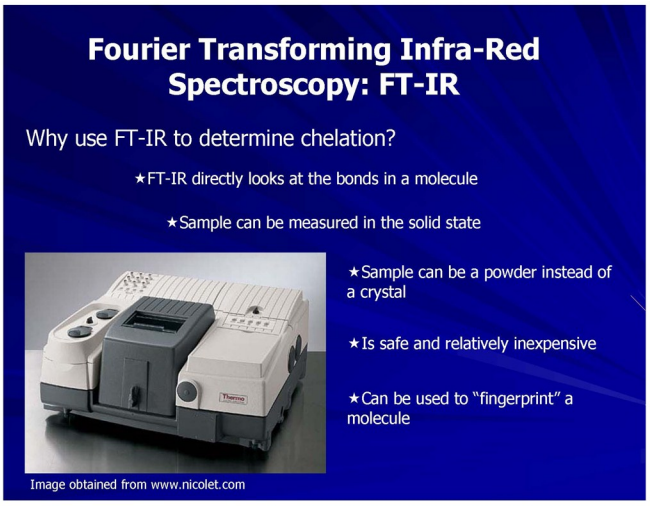
and

How much of the feed additive is chelated?

These questions can be answered using FT-IR analysis which produces a "finger-print" of the product under test.

This validated and approved method of analysis looks at the chemical bonds which are unique to a chelate structure. In the past indirect methods of analysis were used (solubility, metal to amino acid ratios) to try and prove the chelate structure, but they were unable to answer the key questions—*Is it a chelate?* - And—*How much of it is chelated?*

Novus are the only company able to answer these questions using a direct measurement of the bonds which bind the mineral to the amino acid.



SUMMARY

> **Novus Metal Amino Acid Chelates (MAAC) use Glycine as the chelating agent.**

> **Glycine, as the smallest amino acid, has benefits in producing a lower molecular weight chelate, which can be precisely defined in chemical terms and is capable of being analysed quantitatively, including measuring the degree of chelation.**

> **Replicated trials have reported significant improvements for the Glycine MAACs over inorganic mineral salts for milk production, fat and protein yields, and in key reproductive indicators including services per conception, open days and pregnancy rate.**

> **EU Feed Additive registration has been obtained for this range of MAAC which continues Novus's technical expertise in supplying bioavailable minerals to the benefit of animal health and productivity.**

REFERENCES—

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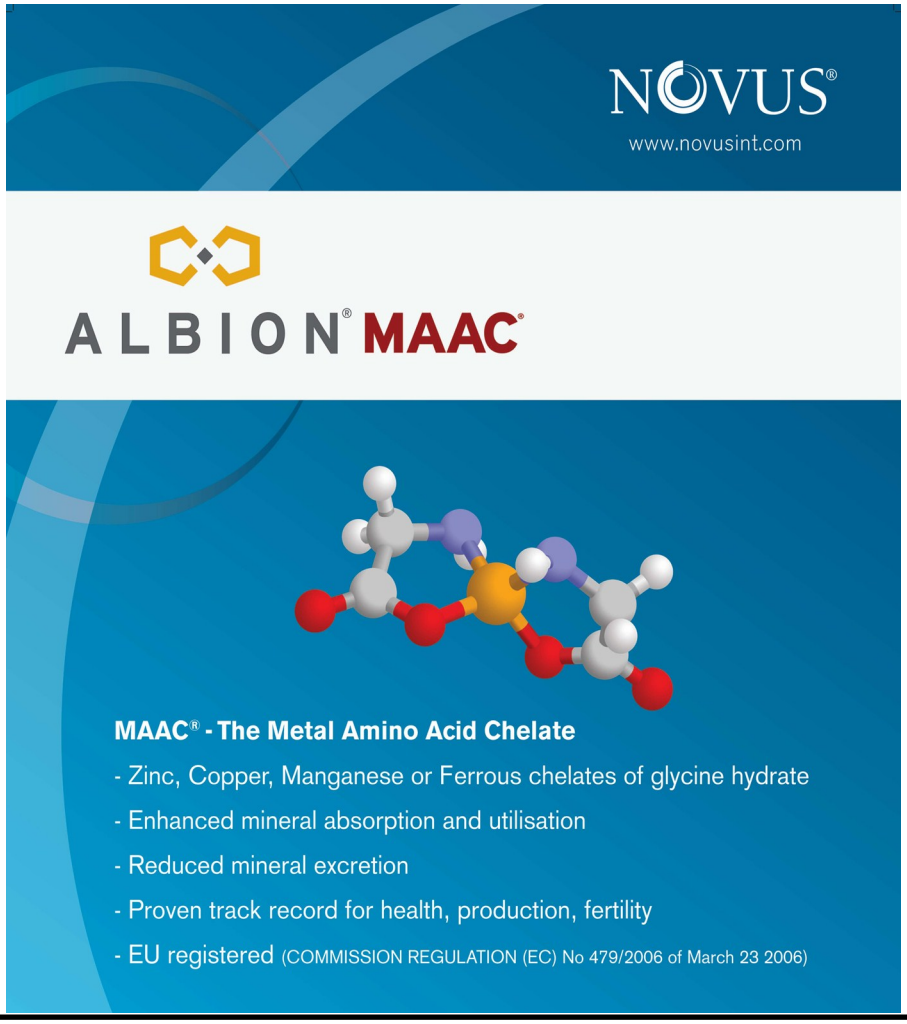

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