# Closing the knowledge gap on trace mineral supplementation

Sound and well conducted research on trace minerals, particularly in dairy cows, is scarce and yet much needed, according to Dr Liam Sinclair, Reader in Animal Science at Harper Adams University College (HAUC).

Over the years he has become frustrated by the number of claims made on the basis of anecdotes, rather than peer reviewed literature, and hence he welcomed – several years ago now – the opportunity to embark on a long term project looking firstly at zinc and now copper in high performing milking cows.

Utilising the full scope of the HAUC dairy cow research facilities and analytical laboratories, the three year study on zinc has already been the basis of one PhD, and a similar programme is now underway in relation to copper. As Dr Sinclair is keen to stress, significant funding is an essential prerequisite to studies of this scale, and the rewards are far reaching.

"The zinc study took the form of a Knowledge Transfer Partnership (KTP) with financial support jointly provided by DEFRA and Alltech, and as a result of this joint commitment we have been able to conduct a very thorough programme of research," he explains. "We are covering the fundamentals and following this right through to applied and practical aspects such as the form and rate of supplementation of the trace mineral. It means that our results have value for scientists, nutritionists and farmers alike.

***The new dairy unit has 32 individual feeding bins that identify cows when they enter and automatically record the time spent eating and the amount of feed consumed.***

"There has been very little research of this calibre on the effects of trace minerals in dairy cows, and much of the work that is recorded has either been done with trace mineral combinations – making results difficult to interpret – or it has neglected to take account of background levels in the ration. Furthermore, the feed industry is generally working with very old inclusion rate recommendations for trace minerals. We do not really have an accurate understanding of how modern high genetic merit dairy cows should be supplemented, and the picture is clouded further when we introduce the concept of organic minerals.

"At HAUC we have a longstanding relationship with Alltech, which as a company has been very keen to carry out thorough research on its Bioplex organic trace mineral range. As a research organisation, we have studied the efficacy of these trace minerals in pigs and sheep, and now we are involved with these dairy cow studies. It is very refreshing to share this desire to understand how these products work, rather than to simply measure the effects."

Alltech pioneered the science behind its Bioplex organic trace mineral range. Trace minerals including zinc, copper and manganese are available in the Bioplex form, in which the elements are bound organically to amino acids and peptides and are therefore presented to the animal in the same way that they are in their natural organic state in forages. This means the trace minerals may be absorbed more efficiently by the animal than inorganic minerals, and are more available at the target tissues.

Over the time that Alltech has been developing its Bioplex range, continuing research has enabled the application to evolve

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***The new Harper Adams University College dairy unit caters for 400 cows and is run as a commercial operation, but has state-of-the-art research facilities.***

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through a series of stages, culminating in the current recommendation of total replacement of the inorganic equivalent.

Total replacement is a new and exciting concept and, according to Alltech's European Ruminant Technical Manager Sylvie Andrieu, it is the breakthrough that will ensure dairy cow nutrition catches up with – and in future keeps pace with – genetic progress.

"Throughout the modern dairy farming era there has been a need to supplement key trace minerals such as zinc, copper and selenium because basal diets are generally deficient," she explains. "When cows were averaging around 5,000 litres, deficiencies could be met by conventional inorganic minerals, and this has been perfectly adequate."

"However, with continued genetic progress, yields have increased and we are now often faced with far greater nutritional challenges. Whilst we've been relatively successful at supplying protein and energy to meet the dairy cow's requirements, trace mineral deficiencies have become more and more of an issue in high performing cows."

| | Treatments | | | | Significance | | | |
|---|---|---|---|---|---|---|---|---|
| | HI | HO | LI | LO | s.e.d | L | F | LxF |
| Milk yield (kg/d) | 35.2[a] | 37.6[b] | 36.0[ab] | 35.2[a] | 0.96 | 0.268 | 0.247 | 0.026 |
| SCC (log (base e)) | 3.97[a] | 3.93[a] | 4.35[ab] | 4.55[b] | 0.430 | 0.022 | 0.717 | 0.587 |
| Milk Amyloid A (µg/ml) | 0.90[a] | 0.88[a] | 1.21[ab] | 1.57[b] | 0.295 | 0.023 | 0.412 | 0.375 |

H = high, L = Low, I = Inorganic, O = Organic. L= main effect of level of Zn, F = main effect form of Zn, LxF = interaction between level and form of Zn.
[a] within a row, means without a common superscript letter differ (P<0.05)

***Table 1. Effect of level and form of dietary zinc on dairy cow performance and health.***

Organic minerals, which in Alltech's case include selenium as Sel-Plex, based on a specific strain of Saccharomyces cerevisiae CNCM I-3060 as well as the Bioplex organic trace mineral range, have been available for almost 20 years, but are only now starting to be used in a total replacement context.

"Supplementation has been through several stages of development since organic minerals first became available," added Sylvie. "Initially they were used on top of the full inorganic mineral ration, and then we've been through a period of partial replacement. Finally we have sufficient research and understanding and the industry is in a position to take full benefit with total replacement."

As with all the earlier steps in this evolution of mineral use, the total replacement concept is based on sound science, and the HAUC study has been a key part of an important process.

"There are pressures on the farming industry to reduce trace mineral feeding levels due to concerns over the potentially harmful effects of residues, so it is important that we increase our understanding of their role and improve the efficiency with which they are fed," Sylvie continues. "Zinc is one of the more important trace minerals, having a role in over 300 enzyme processes – many of which are inherently linked to health and performance.

"This research programme had a number of different facets, comparing one of the more common conventional forms of supplementation – inorganic zinc oxide – with organic Bioplex Zinc. These were fed at recommended daily levels and at reduced levels, and monitored the effects on milk yields, somatic cell counts and locomotion.

"Digestibility studies were also conducted with both forms of zinc at the recommended daily rate and lower rate, to establish absorption and retention levels and therefore the amounts excreted.

"From the results it is clear that there are significant advantages to be gained from using organic forms of the mineral, and – contrary to the current common practice – we can see that total replacement of inorganic minerals with an effective organic supplement is both achievable and beneficial."

The first phase of the research involved 44 early lactation Holstein Friesian dairy cows.

All cows received a total mixed ration of maize, grass silage, urea treated wheat, soyabean meal and rapeseed meal on an ad lib basis. Zinc supplied by the basal diet was predicted to be 81 1mg/day and this was then supplemented through the concentrate ration with either zinc oxide or Bioplex Zinc to supply the NRC 2001 recommended daily level (an additional 600mg/day) of the trace mineral or a reduced level (an additional 120mg/day, representing two thirds of the recommended level).

Milk yields were recorded daily over the 14 week period of the study, and milk samples were taken at the outset and then fortnightly to monitor somatic cell counts.

Averaged over the 14 weeks, cows receiving recommended levels of zinc in the organic Bioplex form yielded 37.6 litres/cow/day, 2.4 litres more than those on the inorganic zinc ration, also at the recommended level. In terms of somatic cell counts, it is important to note that the average level of all the cows was low at 130,000 cells/ml, and despite this, those on the higher zinc ration had significantly lower values by week 12 of the study, irrespective of the form of supplementation.

***Harpers Adams University College has invested in an Inductively Coupled Plasma Mass Spectrometer, giving its laboratory function significant additional resources for mineral analyses.***

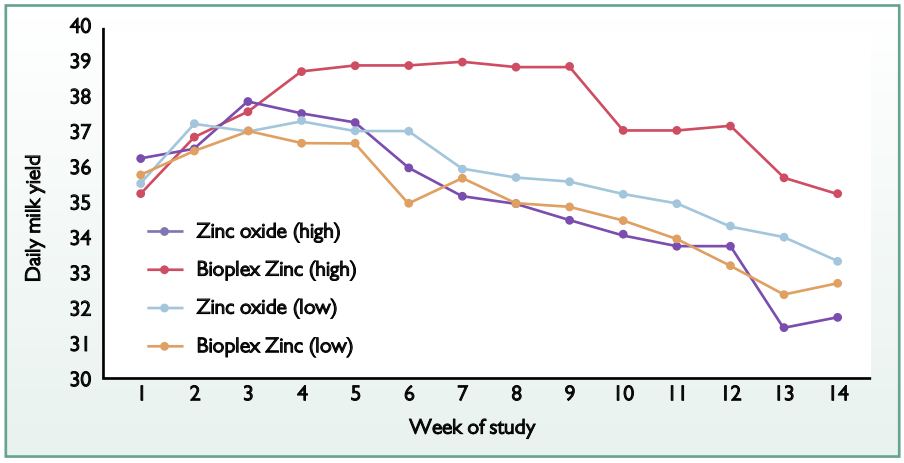


***Fig. 1. Effect of level and source of supplemental zinc on milk production.***

"We first started to see an increase in milk yield in the cows receiving the organic zinc in week six, and this became significant in week seven," comments Dr Liam Sinclair.

"By the end of the trial period there appeared to be greater lactation persistency in the cows receiving the recommended level of zinc in the organic form."

The milk yield increase recorded from feeding Bioplex Zinc at the recommended rate was repeated in a later phase of the research, this time at a lower dose rate.

"We saw a trend for a similar uplift in milk production when the organic zinc was fed at 0.86 of the NRC recommended level," adds Dr Sinclair. "This suggests that the greater efficacy of this organic form of the supplement could allow lower feeding levels without a detrimental effect on performance. Allied to the concept of checking background levels in the basal ration and factoring this into the rationing, it is clear that there are significant improvements in trace mineral supply that can be made. This is important because excretion rates are primarily related to intake, so feeding less will result in lower amounts excreted in the environment."

With a new 400 cow dairy unit now operational at HAUC, the research facilities at Liam Sinclair's disposal are better than ever, and his first major commitment is to extend the trace mineral studies with Alltech, this time looking at copper.

As with the zinc study, a three year programme is scheduled, and the first year will look at the effects of different forms of copper supplementation – comparing organic Bioplex Copper with inorganic copper sulphate – across a group of 56 milking cows. In the second year, the effect of the different forms of supplementation on fertility will be investigated.

"We are again embarking on a very thorough programme of research, and will be using molecular diagnostics to study gene expression for example, so covering everything from the fundamental science through to practical applications," concludes Dr Sinclair. "We hope to have closed the knowledge gap on copper considerably by the time this work is complete." ■