

Selenium – the CEO of antioxidant defence

by Dr Jules Taylor-Pickard, Technical Team Manager, Europe

Selenium (Se) is considered to be one of the most controversial trace elements. Not only is it toxic in excess, but the environmental impact of Se contamination has been well documented. However, Se deficiency is a global problem which manifests itself in the increased susceptibility, of animals and humans alike, to disease and a decrease in the productivity and reproductive performance of farm animals.

Selenium aids the regulation of some of the body's major physiological functions and is an essential part of at least 25 selenoproteins. Of these, glutathione peroxidase (GSH-Px) is perhaps the best known.

Important role in defence

Selenoproteins play an important role in antioxidant defence, regulating the redox status of the cell as well as the regulation of gene expression.

Selenium also controls thyroid hormone metabolism and semen quality is very much dependent on Se status.

Indeed, we could say that the body's antioxidants work together as a team called the 'antioxidant system' and in this team everybody has their own role, with Se the so-called 'CEO' of antioxidant defence. Vitamin E activity in the body is very much dependent on Se status and without Se, vitamin E is not effective. Se is also involved in the prevention of protein oxidation and this could be the mechanism behind the positive effect of Se on milk stability during storage and reduction in drip loss of meat. It is interesting to note that vitamin E does not prevent protein oxidation.

Recent research has shown that Se efficiency is very much dependent on its form, the natural organic form of Se has been proven to be the most effective for monogastric and ruminant animals. One such source is Se-Yeast, such as Sel-Plex organic selenium, from Alltech, produced by *Saccharomyces cerevisiae* CNCM I-3060. This is approved by both the US Food and Drug Administration and the European Union and has been proven to be effective for all species, poultry, pigs, dairy and beef cows, sheep, goats, horses, companion animals and fish. The principal advantage of

organic Se for ruminants is improved assimilation. Indeed, most supplemented selenite is reduced to elemental (non-available) Se by rumen bacteria. In contrast, Se-Yeast escapes destruction in the rumen and, as a result, more Se is available for absorption. An additional advantage of organic selenium is due to the accumulation of Se reserves in muscles which can be effectively used during times of stress, when the requirement for antioxidants increases, but typically feed intake is reduced. Therefore, Sel-Plex improves the adaptive ability of farm animals under stress. As there are a multitude of stressors in commercial animal production, increased adaptability to these enables animals to overcome them without compromising immunocompetence, growth, reproduction and productivity.

When Se is supplemented in an organic form more Se is delivered to the colostrum and milk, enhancing the newly born calves' antioxidant defence and improving their viability.

Indeed, in colostrum milk, the principal form of Se is selenomethionine (SeMet) however, animals cannot produce it and therefore only organic Se in the diet is effective.

Immunomodulating properties

In particular, Se is considered to have immunomodulating properties, helping the immune system to react to pathogens adequately: not too high (causes a redistribution of nutrients and affects FCR and body maintenance) and not too low (this does not protect against pathogens).

Communication between different types of immune cells is considered to be a basis for immunocompetence and Se protects receptors (communicating devices of cells) from the damaging effects of free radicals which are produced under stress conditions.

Furthermore, Se deficiency is shown to be an important factor in virus mutation which is relevant to various viral diseases including influenza. For example, recently it has been shown that Sel-Plex has a protective effect on the integrity of the intestine in the case of reovirus infection. ■

Sel-Plex@alltech.com • www.alltech.com



Performance without compromise

by Dr Jules Taylor-Pickard, Technical Team Manager, Europe

Selenium (Se) nutrition of ruminants has traditionally taken the form inorganic Se.

A recent review of the influence of organic mineral forms on the performance and health status of beef and dairy herds has shown that Se deficiency can be associated with a range of disorders, including poor calf health and infectious diseases. For mature dairy cows, significant relationships were found to exist between low/marginal Se status and poor coat and body condition, low fertility, abortion and retained placenta.

The common practice of dietary Se supplementation in an inorganic form together with Se injections have proved to be of low efficiency.

Indeed, part of the selenite consumed is reduced to metallic Se or selenide by rumen bacteria and both of these compounds are not available for further metabolism.

The second part of selenite is incorporated into proteins synthesised by the rumen bacteria which have a low availability for the host. The replacement of sodium selenite by organic Se sources, in particular by selenised yeast in the form of Sel-Plex (CNCM I-3060), from Alltech, has been proven to be an effective source of Se. The extensive dataset clearly indicate the advantages of Sel-Plex including increased Se concentration in blood and GSH-Px activity, approximately double the Se concentration in colostrum and milk and higher Se transfer via the placenta. The advantages of organic Se were summarised by Ortman (1999) and Valle (2001). It was shown that:

- Se-yeast supplementation caused a higher concentration of Se in the blood and tissues of cattle and in milk compared with inorganic Se.
- Suckler beef calves whose dams were supplemented with Se-yeast had a higher Se status than calves whose dams were supplemented with selenite.
- Se-yeast proved to be more effective in stimulating weight gain and liver Se concentrations than sodium selenite.
- Se-yeast was more effective than sodium selenite in raising and maintaining adequate Se concentrations in the tissues of beef cattle.

The main advantage of organic Se for ruminants is related to the improvement of the immune system.

Trials examining the influence of Se on reproduction and the immunity of dairy cows in Florida and California, USA demonstrated that cows fed Sel-Plex had consistently higher plasma Se (~0.086 µg/ml versus 0.068 µg/ml for inorganic selenite).

Cows fed organic Se had higher levels of active, circulating neutrophils (46% versus 36%).

These are important immune cells for destroying bacteria, especially in first calving heifers, and, unlike selenite fed animals, this level did not decline at parturition. Cows on the organic Se diet had numerically fewer problems with retained placenta (RP) and cleansed down more efficiently. In a trial carried out in Canada at McGill University, Ibeagha also demonstrated that neutrophil activity (evaluated as the 'killing' activity of *E. coli* and measured as the oxidative burst occurring in neutrophil cells) was significantly increased when Se dietary supply was raised up to 0.5ppm, with organic Se providing the greatest response. It is important to note that sodium selenite fed to cows could cause detrimental changes in the immune system. Recently, reduced viability of neutrophils exposed to an *E. coli* challenge was observed in Canada at McGill University when sodium selenite was used as the Se source. Contrastingly, no damaging effect was found when Sel-Plex was supplied.

As a result of Sel-Plex supplementation, cow health was improved, with lower somatic cell counts, decreased mastitis and retained placenta and improved conception rates. The benefit to the newly-born calf result from improvements in their antioxidant defences and thermoregulation, leading to better immunity, viability and lower mortality during the first months of the postnatal development. It is quite clear that organic Se in the form of Sel-Plex offers an important solution to the dairy and beef industries, helping to maintain animal health, production and reproductive performance under stress conditions associated with commercial production. ■

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