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 diseases 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. They also regulate the redox status of the cell and are involved in the regulation of gene expression.

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

We could say that all of the body's antioxidants work together as a team called the 'antioxidant system' and that each team player has his own role, with Se as the so-called 'chief-executive officer' of antioxidant defence.

Vitamin E activity in the body is very much dependent on Se status and without Se, vitamin E is ineffective. Se is also involved in the prevention of protein oxidation and this could be the mechanism behind the positive effect of Se on meat by reducing drip loss of meat. It is interesting to note that vitamin E does not prevent protein oxidation.

Recent research shows that Se's efficiency is very much dependent on its form. The natural organic form of Se has been proven to be the most effective for animals. One such source Se-Yeast, in the form of Sel-Plex, organic selenium produced by Saccharomyces cerevisiae CNCM I-3060, has been shown 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 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 animals under stress.

As there are a multitude of stressors in commercial animal production, increased adaptability to these stressors enables animals to overcome them without compromising immunocompetence, growth, reproduction and productivity.

When Se is supplemented in organic form, more Se is transferred via the placenta, and the Se concentration in colostrum and milk is increased. This enhances the antioxidant defence of young animals thus improving their viability.

Furthermore, more Se is transferred to the spermatozoa improving semen quality. In eggs, spermatozoa, colostrum and milk the principal form of Se is selenomethionine (SeMet) however, animals cannot produce it and therefore only organic Se is effective in the diets of all aforementioned cases.

Immunomodulating properties

In particular, Se is considered to have immunomodulating properties, helping the immune system to react to pathogens adequately: not too high (this 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. In this regard, Se protects receptors (the cell's communicating devices) 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 avian influenza. Recent research has shown that Sel-Plex has a protective effect on the integrity of the chicken intestine, in the case of reovirus infection. ■

Performance without compromise

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

Selenium (Se) is an essential element in pig nutrition and its optimal status is important to maintain sow health, piglet growth and development, as well as meat quality. The replacement of sodium selenite with an organic Se source (such as Sel-Plex, organic Se produced by Saccharomyces cerevisiae CNCM I-3060) in sow and piglet diets, like in other species, is associated with the improvement of health, production and meat quality.

One of the main concerns associated with newly-born piglets is the low efficiency of their antioxidant defence. This is largely due to the placental restriction of antioxidant (for example vitamin E and Se) transfer from the sow to the piglet.

Therefore, increased Se transfer via the placenta, colostrum and milk will improve the antioxidant defence of the piglet, which will benefit the piglet's general health. A maternal diet which is Se deficient has been proven to endanger both the sow and the developing pig embryo.

In-depth study

An in-depth study investigating the effects of maternal Se on piglets was carried out recently by Professor Mahan at the Ohio State University.

The results showed that Se from Sel-Plex was more effectively transferred to colostrum, milk and sow hair, but that a combination of organic (0.15ppm) and inorganic Se (0.15ppm) was not effective at increasing the Se content of colostrum and milk above that achieved with 0.15ppm Sel-Plex alone.

At 0.3ppm dietary supplementation, Se levels in the liver, loin and pancreas of the sow were substantially higher when organic Se was used in the diet compared to an inorganic source.

Similarly, in neonatal pig liver and loin, Se concentration was twice as high as in piglets from sows supplemented with sodium selenite.

Furthermore, the total Se content in neonatal piglets was doubled when Sel-Plex was used in sow diets.

It is also interesting to note that the sodium selenite fed to sows had some detrimental effects on piglets. The percentage of piglets with splay legs, as well as stillborn piglets was increased by the selenite supplementation of the maternal diet. In contrast, under the same conditions, organic Se had protective effects. It could well be that the pro-oxidant properties of selenite are responsible for these detrimental changes in the sow's progeny.

More piglets weaned

Validation of this research was carried out under commercial conditions in Iowa, USA. Here, inorganic Se was substituted for Sel-Plex (0.3ppm added Se) in the diet of commercial sows. This resulted in more piglets weaned with lower pre-weaning mortality (9.76 vs. 11.3%, Sel-Plex vs. sodium selenite).

Furthermore, culls were reduced in nursery pigs weaned from sows given organic Se. In fact, the authors calculated that the improved Se status of sows and piglets, due to the inclusion of Sel-Plex in the sows' diets, was associated with lower piglet mortality, resulting in an extra 0.5 piglets weaned/sow/year. Therefore, the replacement of sodium selenite with Sel-Plex in sow diets is very cost effective.

The replacement of sodium selenite with Sel-Plex in the piglet diet is associated with a significant increase in the Se content of the muscles and such pork is often referred to as Se-enriched pork, since 100g of it can deliver about 30ug Se (half the RDA of Se for humans). Se-enriched pork is already being produced commercially in Korea and Canada.

Furthermore, ongoing research shows that an increased Se level in pork is associated with a reduction in drip loss during storage, which is an indicator of enhanced meat quality.

In conclusion, it is just a matter of time before sodium selenite will be completely replaced by organic Se.

Indeed, for the pig producer, it is a natural way of improving the efficiency of pig production, animal health and the quality of pork. ■