Do not compromise on selenium supplementation

Effective selenium supplementation increases the selenium status of cattle and provides optimal antioxidant protection. This ensures the performance of dairy cows and calves, particularly during times of stress. Under challenging conditions, ensuring optimal selenium status maintains a higher level of both milk yield and quality.

by Aurélie Moal, Global Marketing Manager, and Michele De Marco, Global Scientific & Technical Manager, Adisseo. www.adisseo.com

Immunity is also supported, as cattle receiving a specific form of organic selenium have lower: metritis, somatic cell counts and incidences of subclinical mastitis; as well as improved fertility. When a cow has greater selenium body reserves, she is able to pass more on to her calf; mainly via colostrum. This improves calves' immunity, helping them face challenges and supporting growth.

Stress in dairy production

Cattle are subject to a variety of physiological, sanitary, environmental, technological and nutritional stresses. These stresses are responsible for significant economic losses in commercial dairy production. Physiological stresses include pregnancy and parturition, whilst heat stress is a common environmental challenge.

Bacterial and viral challenges are also well known to trigger the redox balance of the body. Stress can have a greater impact on dairy cows when it occurs during critical physiological periods – for example during the transition period, at calving or during the peak of lactation. This in turn leads to more incidences of subclinical mastitis in cows or diarrhoea and morbidity in calves.

These stresses increase free radical production, resulting in oxidative stress. At the cellular level, high level of free radicals (ROS and RNS) cause lipid peroxidation, protein oxidation and DNA damage – impairing cell functions and damaging tissues.

Moreover, those reactive molecules can activate several transcription factors and nuclear receptors which are implicated in the pathogenesis of the inflammatory and immune disorders, having a direct negative effect on the health status of cattle.

In terms of herd performance: milk production, growth and reproductive performance are decreased.

Negative effects on fertility in both male and female cows are seen; as well as poorer colostrum quality.

The antioxidant function of selenium

To counteract the negative effects of free radicals, the body has several lines of defence: scavenging free radicals, detoxifying their metabolism products and repairing damaged molecules. These systems work by producing biological antioxidants, including enzymes. If dietary antioxidants are added to cattle feed, animals' antioxidant defence systems are improved.

The players in the antioxidant system are fat-soluble antioxidants (vitamin E), water-soluble antioxidants (vitamin C), antioxidant enzymes (GSH-Px) and the thioredoxin system.

Together they work as a team to protect the body, with selenium as the chief executive.

Selenium is a key component of two amino acids, selenomethionine (SeMet) and selenocysteine (SeCys). SeMet is the natural storage form of selenium, which is actively transported through the intestinal membranes.

It is incorporated in rumen bacterial protein before being absorbed in the small intestine and deposited, as a methionine source, in animal protein acting as a safe storage of selenium.

These body selenium reserves are then available to ensure adequate levels in blood, milk and colostrum. SeCys is the active form found at the catalytic site of selenoproteins, many of which play an important role in antioxidant defence, for example Glutathione peroxidase. Selenoproteins are also involved in thyroid metabolism, spermatozoa function; inflammatory and immune responses.

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Fig. 1. Fate of different sources of selenium in the rumen.

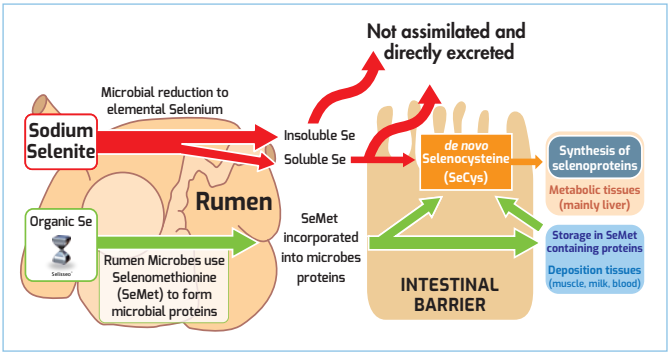
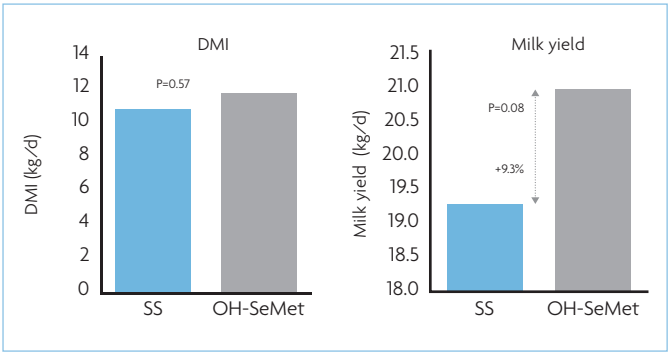


Fig. 2. Effect of OH-SeMet on dry matter intake (DMI) and milk yield during heat stress.



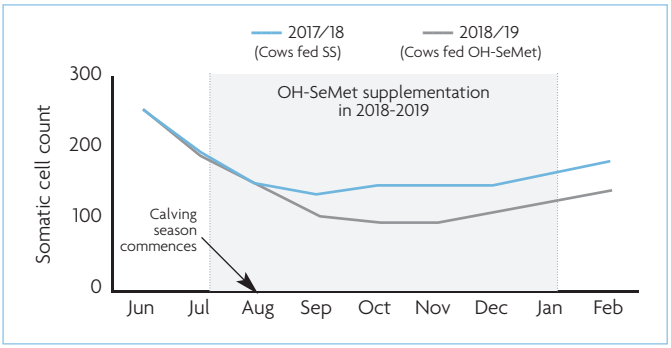


Fig. 3. Effect of OH-SeMet on somatic cell count (SCC).

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The importance of the selenium source

Selenium has historically been added to animal diets in the inorganic form sodium selenite. The use of organic forms is increasing; including SeMet and selenised yeasts. The amount of SeMet in selenium yeasts is highly variable, from 15-70% maximum, which limits their effect on selenium status. Hydroxy-selenomethionine (OH-SeMet) is a pure, chemically synthetised form of organic selenium, as such its consistency and reliability are assured. It is also safe, stable and easy to use in animal feed applications.

OH-SeMet has been shown to be very effective at increasing Se deposition in the tissues. By enhancing Se levels in tissues, a reserve of selenium is created, available for use when animals are suffering from oxidative stress. Experiments have shown that feeding OH-SeMet results in higher levels of selenium in plasma, milk etc; than sodium selenite and seleno-yeasts.

Dietary forms of SeCys cannot be stored as SeMet and they cannot be directly incorporated into selenoproteins, as it has to be created de novo for this purpose. Therefore, adding SeCys to the diet, would be of no greater benefit than supplying inorganic selenium, such as sodium selenite. Much of the inorganic selenium fed is transformed into elemental selenium, by reduction in the rumen environment, in this insoluble form it is then unavailable to the animal (Fig. 1). In ewes, 3.8 times more SeMet was incorporated into rumen micro-organisms than sodium selenite. This research explains the higher bioavailability of SeMet and OH-SeMet compared to inorganic forms of Se.

Selenium deficiency and the effect of climate change

In the absence of supplementation, ruminants depend on the selenium present in grass, forage or cereals. In turn, the level within these plant sources is dictated by the availability of selenium in the soil.

Even if soil contains adequate levels of selenium, factors including acidic pH and incomplete aeration due to water logging promote the formation of insoluble complexes of elemental selenium and sodium selenite with iron oxide. Selenium deficiency in dairy cows can lead to:

- Poor fertility.
- Longer service to calving interval.
- Less transfer of selenium via colostrum to calves.
- Reduced calf growth and health.
- Increased susceptibility to mastitis.
- Higher somatic cell counts.
- Poorer immune status.

For instance, in Europe there are many regions where the levels of selenium in soil are very low; and sub-optimal levels of selenium in both animals and humans are reported. Higher levels of rainfall and lower soil pH are predicted due to climate change, increasing the likelihood of poor selenium status in cattle. A moderate climate change projection predicted that globally the soil in 66% of agricultural land would contain 8.7% less selenium.

The effect of optimal selenium supplementation on dairy cattle

Supplementation with OH-SeMet increases the selenium status of cattle and provides optimal antioxidant protection. Greater effects are seen in dairy cattle fed OH-SeMet, compared to both selenium yeast and sodium selenite. The effects of OH-SeMet ensure the performance of dairy cows and calves, particularly during times of stress. During heat stress, it has been shown to maintain a higher milk yield, despite a similar drop in dry matter intake as cows fed sodium selenite (Fig. 2).

This improvement in milk yield was positively correlated with a greater total antioxidant capacity; as well as a lower level of circulating plasma nitric oxide and hydrogen peroxide.

Researchers have demonstrated a direct correlation between mean herd plasma selenium and the level of SCC in the milk tank. Cows fed OH-SeMet have lower metritis, somatic cell counts and incidences of subclinical mastitis (Fig. 3). When a cow has greater selenium body reserves, she is able to pass more on to her calf mainly via colostrum (Fig. 4). This improves calves' selenium status, helping them better face the first challenges after birth and supporting their growth.

Providing OH-SeMet to cattle helps build their reserves, so that during periods of stress, they can combat oxidative stress. Selenium availability and stress are major factors that determine selenoprotein expression. As well as ensuring the effectiveness of the antioxidant system, it supports immunity and fertility.

Adequate selenium status is essential to maintain the performance of dairy cattle. However, the form of selenium supplementation is key to the ability of a product to help cattle reach their full potential. ■

Fig. 4. Total Se content and the proportion of total Se comprised of selenomethionine (SeMet) or selenocysteine (SeCys) in the colostrum of fresh calved heifers (NC: Negative control, SS: Sodium Selenite, OH-SeMet: Hydroxy-selenomethionine).