Heat stress: The positive effects of selenium

Heat stress has a dramatic impact on feed consumption and milk production in dairy cows. It is responsible for large economic losses in the livestock industry. Documented evidence has proven that selenium can effectively alleviate heat stress in dairy cows.

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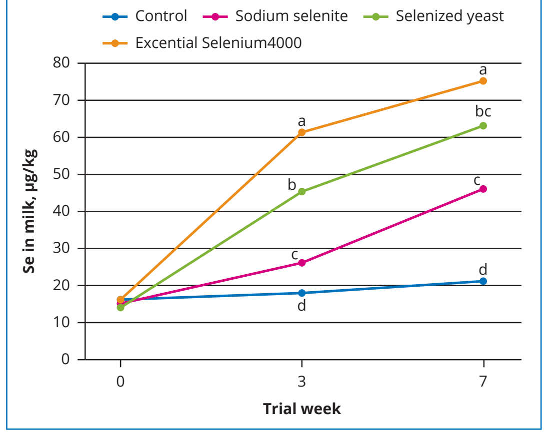
Heat stress in all animals elicits a physiological response resulting in elevated internal temperature. To get back to homeostasis, dairy cows will increase respiration rate, panting and sweating which leads to energy expenditure taken away from milk yield and reproductive performance. Meanwhile, dry matter (DM) intake is reduced. Animals with this status are more prone to secondary bacterial infections that can also contribute to poor performance. Cows are especially at risk around parturition, specifically from week-1 to peak lactation. Strategies to reduce oxidative and metabolic stress associated with inflammation are necessary. Along with management solutions to alleviate heat stress such as installing sprinklers, adding an adequate source of selenium that can change the immunological and physiological status is an option to combat heat stress. Excential Selenium 4000, a pure L-selenomethionine dust-free feed preparation, is a readily available form which provides the highest selenium deposition, while reducing oxidative stress by decreasing free radicals and inflammatory response to sustain performance under stress conditions.

Figure 1 - Selenium deposition in milk.



Selenium improving immunity status

There is documented evidence that Excential Selenium 4000 (Se4000) increases the deposition of selenium in livestock including equine, swine, broilers, layers and dairy relative to both selenite and selenised yeast. As seen in *Figure 1*, a total of 24 Holstein Friesian cows, originally on a low Se diet, were placed on one of the four following treatments:

1. Control (no Se supplementation);
2. Sodium selenite (Control + 0.3 ppm Se from sodium selenite);
3. Selenised yeast (Control + 0.3 ppm Se from selenised yeast);
4. Excential Selenium 4000 (Control + 0.3 ppm Se from Excential Selenium 4000).

The inclusion of Se4000 resulted in the highest deposition in milk: 61% increase relative to selenite and outperforming selenised yeast. This also translates to improved Se deposition in colostrum, which can lead to improved passive immunity. This is because L-selenomethionine can be stored in the body in replacement of methionine. As a result, selenium in the form of L-selenomethionine is incorporated and stored in muscle, milk and blood and can be mobilized via selenide to de novo selenocysteine in the liver and subsequent enable selenoprotein synthesis when required. Although selenised yeast has some L-selenomethionine and other organic selenium derivatives, those other derivates cannot be incorporated into animal proteins the same way; less selenomethionine means less deposition and storage reserves.

The more readily available L-selenomethionine (Se4000) allows for improved immune status. In mammals, it was discovered that providing L-selenomethionine significantly lowered expression of *Cyclooxygenase-2* (*Cox2*) and interferon gamma (*Ifny*) relative to selenite, and numerically lower relative to selenised yeast, during normal production. These genes are involved in inflammation when elevated. In the same study during a pathogen (lipopolysaccharide) challenge, mammals that were given selenite as their selenium source had a gene profile that indicated oxidative stress (elevated up-regulation of *Txnrd1, Cat, selenogenes SelS* and *SelN1* before challenge and an immediate down-regulation of *Gpx1*). Those given an organic source (selenised yeast and Se4000) did not have the same profile. Specifically, Se4000 had an up-regulation of regulatory cytokine interleukin 10 (IL10) which depresses inflammation during times of challenge, redirecting energy away from an inflammatory response to a response important to the producers: performance.

Reducing secondary pathogens

Improving immunity during times of stress can reduce secondary pathogen overgrowth and infections. Proper selenium supplementation can improve the efficiency of leucocytes and antioxidants such as glutathione peroxidase. Without a proper antioxidant defence mechanism, cows can become susceptible to immunosuppression. One study investigated the effect of dietary selenium supplementation on milk composition. Somatic cell counts were significantly lowered by 26% in dairy cows that were given L-selenomethionine for 63 days compared to selenite. Somatic cell counts in the L-selenomethionine treatment were all below 200,000 cells/mL, which is the sensitivity threshold for detection of mastitis. In the same study, free fatty acids were altered in the L-selenomethionine treatment including an increase in conjugated linoleic acid (CLA), rumenic acid. Mammary function can be improved with elevated CLAs by protecting bovine mammary epithelial cells from lipid peroxidation and reducing the levels of reactive oxygen species. Reducing lipid peroxidation can also be evident in dairy products, where L-selenomethionine was shown to reduce lipid oxidation in caciocavallo cheese.

Selenium in ruminants

Selenium absorption tends to be much lower in ruminants relative to non-ruminants due to the ruminal environment creating insoluble forms of selenium. Absorption of inorganic selenium can be as low as 13% in steers and as low as 10–16% in non-lactating and lactating cows. In ruminants, it is especially crucial to provide a selenium source that is readily available.

Heat stress is associated with decreased milk production, increased disease incidence and impaired reproduction. In a commercial dairy study, cows were deficient in selenium (below 65 µg Se/L blood). A total of 30 Friesian cows had diets that included 0.2 ppm Se from selenised yeast replaced by 0.2 ppm Se from Se4000. In two weeks, Se in the blood significantly improved and was no longer deficient (67 µg Se/L).

At eight weeks, Se in the blood continued improving (76 µg Se/L) despite elevated ambient temperatures (average 71.6ºF [22ºC]).

High ambient temperature during late gestation can also influence the transfer of passive immunity to calves. This can lead to a poor start for these calves. In a commercial trial with two equal groups of 48 cows, selenised yeast (0.15 ppm Se prior to calving) and sodium selenite (0.15 ppm Se prior to calving and 0.45 ppm Se after calving) were replaced by 0.20 ppm Se from L-selenomethionine as Se4000 prior to calving and after calving in the trial group. One month after calving, suckler cows in the L-selenomethionine group had significantly improved selenium content in the milk by 85%, and their calves had adequate levels of Se in the blood (67 µg Se/L). In addition, the proportion of cows that received more than one artificial insemination reduced by 13% in those given Se4000.

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Priming the immune system with selenium

Heat stress can elicit a number of physiological responses, causing inflammation and imbalance to the immune system in dairy cows that can affect performance and overall well-being. By priming the immune system with adequate levels of readily available trace minerals such as selenium in the form of L-selenomethionine (Se4000), dairy cows are better equipped to regulate homeostasis through regulating oxidative and metabolic stress and to have the reserves available when needed.

References are available on request