Minimizing the negative effects of stress on herd health and productivity

Drew Dickson for *Progressive Dairyman*

AT A GLANCE

Chromium supplementation improves insulin sensitivity, reduces the release of stress hormones and enhances reproductive health.

Chromium supplementation minimizes the negative effects of the stress response by consistently decreasing serum cortisol during stressful periods for cattle and other species. Chromium supplementation primarily acts to improve insulin sensitivity and reduce the release of stress hormones, both of which enhance reproductive health – namely, uterine immune cell function and restoration of the ovarian cycle after calving.

Stress, immunity and reproductive health go hand in hand in the life of a dairy cow, but how do these factors impact the health of your herd as a whole? According to research, diseases which exist at certain prevalence rates within the herd are detrimental to the overall reproductive health of that population of cows. Additionally, stress can play a large role in the ability of an animal to mount an immune response that will fight off reproductive diseases. Therefore, improving immune function to improve overall herd health is vital to minimizing production losses to dairy producers.

The cost of reproductive diseases/conditions

The reproductive health of a dairy herd is crucial to a successful dairy business. Cow infertility, abortions/stillbirths, dystocia, retained placenta and metritis cost the industry nearly half a billion dollars annually, according to the USDA National Animal Health Reporting System. Mastitis alone costs the dairy industry nearly $2 billion per year.

Diseases may incur costs to producers in a number of direct and indirect ways, including:

- Veterinary fees
- Medications
- Discarded milk due to drug residue
- Decreases in milk production due to reduced feed consumption
- Delayed conception
- Pregnancy loss
- Culling replacement costs
- Decreased slaughter value
- Death

Working backward from the state of disease to an originally healthy cow can help lead us to solutions that decrease the costs associated with compromised reproductive herd health. Typically, viruses or bacteria within the herd cause reproductive disease, but why? Most likely, the immune system has been compromised and is not adequate to ward off these pathogens. If we continue to move backward and ask how the immune system has been compromised, we see stress can suppress the immune system, impairing its ability to maintain the reproductive health of the animal.

The stress response and immunity

Stress, such as that experienced during the transition period, is commonplace within the dairy herd. Reproduction management is hard work. Therefore, it is necessary to consider how to minimize the negative effects of stress on the immune system to ultimately improve reproductive herd health and

minimize profit loss.

Stress can generally be defined as the physiological or behavioural adjustment an animal makes to cope with a stressor and maintain balance or homeostasis. In the event of a stress response, glucocorticoids (primarily cortisol) and catecholamines (adrenaline and noradrenaline) act to alter carbohydrate and protein metabolism, growth, reproduction and immune function. Upon the initiation of a stress response, a nutritionally demanding immune response may be stimulated. Continuation of that stress response leads to the continual release of cortisol in the dairy cow.

In cattle, cortisol has been associated with:

- Reduced rates of reproduction
- Suboptimal growth
- Suppressed milk production
- Suppression of the immune system that leads to greater reproductive disease susceptibility

Activation of the immune system by these common stressors leads to inefficient feed utilization due to consumption of nutrients by the immune system. Subsequently, reproductive efficiency is impaired. Despite the increase in nutrients required by the immune system, activation of the immune system also leads to a decrease in feed intake, which further exacerbates the problem.

Typical stressors in the life of a dairy cow

The average lactating Holstein cow produces approximately 34 kilograms per day of milk and consumes 22.5 kilograms of dry matter. This high level of production places pressure on the cow as it undergoes the reproductive cycle. The period between late pregnancy and early lactation is especially critical for dairy cows, in which several stressors may present themselves.

Some of these potential stressors include:

- Calving
- High genetic production
- Retained placenta
- Infection (mastitis/metritis)
- Heat stress
- Early lactation
- Negative energy balance/ketosis
- Social stressors

TABLE 1 Effect of chromium supplementation on endometrial cytology

Item	Treatment			
	Control	Cr-Pro	SEM	P-Value
	– Mean –			
7 d postpartum				
% of neutrophils	32.8	41.1	4.1	0.15
40 to 60 d postpartum				
Subclinical endometritis[1] (# head)	16	8	–	0.02
Head (# head)	11	20		

[1]Neutrophil >10 percent

TABLE 2 Effect of chromium compared to control cows in higher milk yield and dry matter intake

Study	Increase in milk (kgs/day)	Increase in dry matter intake (kgs/day)
A1-Saiady et al.	3.4	1.7
An-Qiang et al.	1.2	0.5
An-Qiang et al.	1.3	0.5
An-Qiang et al.	1.0	0.3
Soltan	5.4	2.8
Soltan	1.9	1.3
Mirzaei et al.	1.6	2.4
Ferguson et al.	2.6	2.2

[15]Neutrophil >10 percent

High-yielding dairy cows require large amounts of glucose for milk lactose synthesis. However, a stress-induced immune response depletes the necessary glucose for milk production.

Glucose requirements of the immune system

Glucose balance, or homeostasis, is disrupted any time a cow

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experiences an immune insult. Several studies have demonstrated substantial increases in glucose consumption by immune cells during a challenge. A study that investigated the glucose requirements of an activated immune system in Holstein steers observed 43 grams per hour of glucose was required during an endotoxin challenge to maintain normal blood glucose concentration.

One of the first signs of stress and immune challenge in a dairy cow is a decrease in feed intake, making the additional glucose needed even harder to come by. At the same time, cortisol is continually released during a stress response and tells the liver to make more glucose. The pancreas then begins to release more insulin as it attempts to keep up with these changes in metabolism. Insulin plays a key role in optimum cell function by acting as a key in the lock to the door that allows glucose into the cell. However, this vicious cycle caused by stress leads to insulin resistance and decreased glucose uptake by muscle and fat tissues. Therefore, reproductive efficiency and high levels of milk production both require optimum responsiveness of the cow's cells to insulin.

Chromium supplementation improves insulin sensitivity

Chromium, a required trace mineral, has the unique ability to bind to insulin receptors and allow glucose into cells. A maximum of four chromium molecules can bind to one insulin receptor, potentially producing an eightfold difference in insulin receptor activation and enhancing insulin sensitivity. When an animal becomes insulin-resistant, more fat is mobilized, which leads to a decrease in feed intake caused by oxidation of non-esterified fatty acids in the liver. Chromium supplementation helps alleviate insulin resistance in transition dairy cows and minimize this drop in intake.

Reductions in stress, improvements in immunity and increased reproductive efficiency

Chromium supplementation minimizes the negative effects of the stress response by consistently decreasing serum cortisol during stressful periods for cattle and other species. Remember those negative effects of cortisol on reproductive health and productivity? Minimizing blood cortisol concentrations with the help of chromium is desirable to prevent those negative effects.

Various aspects of immunity are also affected by chromium supplementation. Studies have demonstrated certain immune cells, such as lymphocytes, functioned more efficiently, circulating neutrophils were increased, primary and secondary antibody responses to a disease challenge were improved, tetanus vaccine responses were improved, and reduced retained placenta occurred in chromium-supplemented cows. Research at Cornell University suggests supplemental chromium-enhanced immune responses in early lactation to bacterial challenges in the uterus (**Table 1**, page 47).

Much of this improvement in immune function can likely be attributed to the lesser ability of the stress response, in the presence of chromium, to suppress the immune system. Multiple studies have demonstrated a significant increase in feed intake and subsequent milk yield in early lactation dairy cows supplemented with chromium during pre- and postpartum, likely due to the potentiation of insulin action by chromium (**Table 2**, page 47).

It probably goes without saying if stress is minimized and immunity enhanced, improved reproductive herd health will follow. Optimum insulin sensitivity has been associated with earlier restoration of the ovarian cycle after calving, as well as improved uterine immune cell function. Furthermore, milk production has a better chance to be optimum in the presence of reproductive health.

Drew Dickson
Product Manager
Kemin
drew.dickson@kemin.com

Conclusions and practical application

Understanding the relationship among stress, immunity and reproductive herd health is paramount to discovering nutritional management best practices for your dairy herd. Chromium supplementation primarily acts to improve insulin sensitivity and reduce the release of stress hormones, both of which enhance reproductive health – namely, uterine immune cell function and restoration of the ovarian cycle after calving. Ultimately, this improvement in overall herd reproductive health should contribute to lower veterinary/medical costs, lower discounts on cull cows at the packer, improved conception rates and more optimal milk production.

References omitted but are available upon request.