



Report

Information from Phibro Technical Services

Inflammation: Risks and Rewards

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In-flam-ma-tion: a local response to cellular injury that is marked by capillary dilatation, leukocytic infiltration, redness, heat and pain and that serves as a mechanism initiating the elimination of noxious agents and of damaged tissue (Merriam-Webster Dictionary).

When talking about dairy cows, inflammation is most commonly associated with mastitis, or inflammation of the mammary tissue. It is something dairy producers manage on a daily basis and will always be a risk when working with lactating animals.

The physical action of inflammation is essential for a successful immune response. This includes increased blood flow to the impacted area and increased immune cell infiltration into infected and surrounding tissues to locate and destroy invading pathogens. This is good! The reaction is characterized by redness, swelling, pain and heat. This is bad! How can an essential biological function be both good and bad?

It all depends on the circumstances. There are two paths this reaction can take: short or long. Inflammation is the first step of communication within the immune system that something is wrong, but after the immune response resolves the problem, it needs to turn off. This is known as rapid resolution. If the challenge persists and inflammation continues, it becomes chronic. Chronic inflammation comes at a price to the animal and can cause long-term changes in metabolic functions. Therefore, an ideal situation would be a targeted reaction of the immune system to manage or contain the challenge and a rapid resolution to return to normal.

Mastitis in dairy cows is usually caused by an environmental pathogen. One of the ways the immune system destroys pathogens relies on the release of reactive oxygen species (ROS). If you have ever used hydrogen peroxide on a cut, then you understand how ROS can be used to kill bacteria. This is the weapon of choice of the immune system.

The drawback to ROS is it can be harmful to surrounding tissue. In the case of mammary tissue,

excessive or prolonged ROS production weakens the blood-milk barrier, causing an increase in somatic cell concentration in the milk and reduced milk production. The damage to milk secretory cells and/or further invasion of new pathogens can prolong the inflammatory response and it becomes a chronic problem. In the world of inflammation, response time matters!

The benefits of inflammatory signaling, or the mechanism of communication between biological systems to achieve a specific response, diminish the longer it continues. This is because the inflammatory response requires energy. Many organs respond to inflammatory signals and will alter their activity in order to provide energy to the immune system. Glucose, the sugar in blood, is the universal fuel of the body and is an incredibly important energy source for immune cells. The diversion of nutrients to the inflammatory response can limit other important nutrient-demanding functions or cause the cow to excessively mobilize energy reserves. This is especially evident during the transition period when excessive inflammation has been linked to fatty liver disease and prolonged negative energy balance.

Chronic inflammation should be avoided, but the inflammatory response should not. This is because inflammation is an essential part of calving and promoting milk production. Inflammatory signaling and an immune response play essential roles in dilating the cervix, contracting the uterus and releasing the placenta. During the transition period, the cow is in a controlled inflammatory state, using inflammatory signaling for cross-organ communication and allowing for rapid adaptation. For example, after calving, inflammation is needed to direct immune cells to the uterus for cleaning and repair. It has also been theorized that inflammation, through energy diversion mechanisms, may play a role in promoting milk production. In early lactation, mechanisms involved in energy partitioning are credited for establishing the energy balance between the cow's metabolic



needs and the demands of milk production. Therefore, instead of avoiding inflammation completely, it is more advantageous to have an inflammatory response with a rapid resolution to promote a return to homeostasis and a successful adaptation to lactation.

There are many factors that can negatively impact the success of the transition period and cause chronic inflammation. The stress response is one of them. As an example, environmental heat stress has been linked to increased systemic inflammation. This is a whole-body inflammatory reaction instead of a targeted response, such as mastitis. Subacute ruminal acidosis, on the other hand, is linked to “leaky gut” that can induce both targeted and systemic inflammatory responses. This chronic inflammation can lead to an increase in negative health events. Ruminal acidosis is also linked to weakening of the hoof wall and can cause physical challenges such as lameness.

Since it is impossible to remove all stressors on the farm, there are management and nutritional strategies producers can use to encourage rapid resolution and reduce the risk of chronic inflammation. This can be as simple as adding fans to lower heat stress or reducing overcrowding to lower social stress; supplementing antioxidants such as vitamin E to control the damaging effects of ROS; or using commercial nutritional supplements that support the cow’s innate immune system for a more swift and effective immune response. Whatever the method, the goal is for the cow to quickly return to a normal, non-inflammatory state.

When measuring the effects of inflammation, do the risks outweigh the rewards? The answer is... it depends. Inflammation is a powerful immunological mechanism that can both help and harm the cow. By increasing our understanding of the role inflammation plays in a healthy immune system, dairy producers can promote rapid resolutions of the essential inflammatory response through applying nutritional programs and management strategies.

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