How nutrition can be used to improve health and SCC prevention

Somatic cell count (SCC) is the total number of cells per millilitre of milk and is one of the main indicators of milk quality in dairy cows. Somatic cells are made of 2% mammary gland cells and around 98% white blood cells – leucocytes that are immune cells, produced by the cow's immune system.

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Bulk milk somatic cell count (cells/mL)	Estimated loss of milk production (%/cow/year)	Estimated loss of milk production (kg/cow/year)
≤ 100,000	3	180
200,000	6	360
300,000	7	450
400,000	8	540
500,000	9	590
600,000	10	635

Table 1. Relation between SCC and estimated loss of milk production. Based on 6,300-6,800kg average/cow/year (Philpot and Nickerson. 1991. Mastitis: Counter Attack).

As SCC are immune cells, the number found in the milk increases as a response to an immune challenge in the udder. This challenge is usually caused by pathogens and leads to inflammation.

The most important factor affecting the SCC for an individual quarter, and eventually at herd level, is the mammary gland infection known as mastitis. Other factors involved in raising SCC are minor and insignificant compared to mastitis, so this allows us to use SCC as an indicator for subclinical mastitis.

While mastitis is the most common and expensive disease in dairy farms, SCC gives us the opportunity to monitor subclinical cases on an individual and herd level using various SCC tests, such as the CMT (California Mastitis Test) or digital on-farm counters. Mastitis is considered the greatest threat to the dairy industry from three perspectives: economic, hygiene, and legal (EU Directive 46/92, modified by Directive 71/94).

Mechanism

Mastitis is caused by a variety of micro-organisms, the majority of which are bacteria that enter the mammary gland through the teat canal. Mastitis itself is inflammation of the mammary gland in response to the infection caused by these pathogens, and in rare cases, to chemical or metabolic factors.

Appropriate immune function is essential for host defence against intramammary infections. The first and most common line of defence is the innate immune system, which triggers a proinflammatory response. It is a known fact that the mammary gland immune system is compromised during drying-off and around calving, the two periods representing the highest risk of mammary infection.

The mammary gland has a number of defence mechanisms, including different immune cells that react immediately to a pathogen challenge and form the first line of defence. Despite these mechanisms, it has been suggested that the mammary gland is immunocompromised when compared to other parts of the body.

To stop infection, additional immune cells migrate to the mammary gland, raising the SCC and reducing milk secretion due to the increased inflammation.

The first immune cells that are recruited and migrate into the mammary gland are the neutrophils (PMNs), which form an important line of defence.

The primary function of PMNs is to engulf, phagocytise, and destroy foreign material, including invading bacteria. In a perfect situation, the action of these neutrophils would eliminate the bacteria causing the infection. When the immune system is functioning properly, the problem should be rapidly resolved with a short and transient increase in SCC.

However, this is not the case for most cows, especially around calving and drying-off, and during periods of stress, when the immune system is suppressed.

In these cases, the number of mature neutrophils is limited and insufficient, but the bone marrow continues to produce large numbers of immature neutrophils that are mobilised to the area of inflammation.

Several important functions are not fully developed in immature neutrophils, including those related to phagocytosis, intracellular killing, and chemotaxis.

These immature neutrophils make up most of the SCC during clinical or subclinical mastitis, being recruited into the mammary gland in increasing numbers, but they are unable to reduce the pathogen load.

The solution is to reduce the level of bacteria using antibiotics that directly kill them, or to stimulate the immune system to increase the proportion of mature neutrophils capable of destroying the pathogens.

Economic impact of somatic cell count on milk production

Somatic cells are not only a scientific concept, but they are also of great practical importance to farmers. High SCCs are related to a milk premium or penalty, and also directly affect milk production. SCC rises in response to mammary gland infection, causing inflammation and reducing the ability of the mammary gland tissue to produce milk.

The symptoms of acute mastitis are clearly visible and the reduction in milk production is well defined. Financial losses arising from a case of mastitis are related to

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treatment, discarded milk, and hidden costs such as reduced milk yield during the remainder of the lactation period, and the related culling. The earlier the mastitis occurs in the lactation period, the higher the costs.

A case study in five large dairy herds in New York State found that an average case of clinical mastitis had an estimated cost of $179.

This was composed of $115 for milk yield losses, $14 for increased mortality, and $50 for treatment-associated costs.

The estimated cost of clinical mastitis was highly dependent on cow traits: it was highest ($403) in cows with high expected future net returns (young, high-yielding cows), and lowest ($3) in cows that were recommended to be culled for reasons other than mastitis.

The cost of clinical mastitis in a cow in the first 30 days of lactation was estimated at $444.

These are obvious, clinical cases of mastitis that require treatment and special care but most mastitis is subclinical and goes undetected by the farmer, and is not regarded as a potential economic loss.

We can use the SCC as an indicator to evaluate losses from subclinical mastitis. Most farmers will consider the SCC in a similar way to fat and protein, as just a measurement for milk premium or penalty.

Many studies show that changes in SCC are related to economic losses that go far beyond the milk premium.

An increase in SCC has several effects:

- Reduces milk production over the entire lactation.
- Increases the risk of clinical mastitis.
- Increases culling rate due to unacceptably high SCC and mastitis.

An increase in bulk milk SCC to over 100,000 affects milk production (Table 1).

Similar numbers were produced by meta-analysis of a large number of reference studies from the USA, Canada, UK, Germany, and many other European countries.

According to this meta-analysis, when bulk milk SCC is above 100,000, the farm loses about 3% of its milk production.

As well as reducing milk production, a high SCC increases the risk of clinical mastitis and related culling rates.

- Reducing SCC

If we take into account the reduced milk production, and increase in cases of clinical mastitis and culling rates, we can estimate that a farm with 100 cows and average yield of 8,000kg/cow/year could actually gain around €4,000 per year by reducing SCC by from 200,000 to 100,000, depending on milk price.

Investment in reducing SCC can increase dairy farm profitability. Several methods can be considered when building a strategy for SCC reduction.

- Culling

It is recommended that cows with very high SCCs for a prolonged length of time are culled as they are more prone to clinical mastitis and fertility problems. However, culling should be carried out according to an established breeding program, and in collaboration with a vet.

Prevention through medication

The most common method used to fight subclinical mastitis and prevent clinical cases is the use of intramammary antibiotics. Most cows on commercial dairy farms will be treated with intramammary dry cow antibiotics before drying off. This is supposed to prevent bacterial infections during the dry period.

Prevention through hygiene and management

Improving hygiene to reduce mastitis is crucial for udder health and, ultimately, for successful dairy farming. It is simply keeping the udder clean and free of the pathogenic bacteria that cause mastitis. Major teat contamination can be avoided by eliminating mud and preventing the formation of puddles in the cows' walking areas. Keeping bedding dry and clean.

Milking practices

Cleaning and disinfecting the milking machines and the udder before and after milking. Correct vacuum regulation. Higher vacuum levels cause the teat canal to remain open for longer after milking, allowing pathogens to enter the udder.

Increasing the number of milkings per day may also help reduce SCC as the bacteria are expelled from the udder more often.

Dry cow management

The risk of intramammary infection is greatest during the early and late dry period. In the early dry period, pathogens remain from the lactation period, but they are no longer flushed out by daily milking.

Most cases of mastitis in fresh cows are caused by bacteria remaining from the dry period.

Cows should be dried off when individual SCCs are below 200,000 to reduce pathogen levels during the dry period. Cows with higher SCCs should be treated before drying off. If cows are not properly dried off, mastitis can occur during the dry period too.

Dry cows should be monitored for signs

of mastitis, such as redness and swelling of the udder, and treated accordingly.

Nutritional management

Nutrition is involved in maintaining immunity, and insufficient energy and other deficiencies affect the cow's resistance. Nutrient deficiency may lead to negative energy balance and immunosuppression. Well-balanced diets with sufficient nutrients may help support a fully functional immune system, helping reduce SCC. When supplied in the diet, certain probiotics and prebiotics have also proved beneficial to the immune system, supporting a satisfactory immune response and contributing to SCC reduction. Some immune modulation has been documented with some strains of live yeast, such as Saccharomyces cerevisiae Sc 47 (Actisaf) and selected yeast parietal fractions, such as Safmannan.

How does probiotic yeast help reduce SCC?

The small intestine is the largest immune organ in the body and is rich in immune cells (macrophages and dendritic cells). These cells are in constant contact with different pathogens and native flora in the intestinal lumen and their role is to trigger the immune system by providing information.

When the immune system is prepared for a pathogen challenge it reacts quickly and efficiently, with less inflammation and energy expenditure. When the diet is supplemented with Actisaf yeast probiotic and Safmannan, they can interact with the beneficial microflora in the intestine, promoting their growth and strengthening the gut's resistance to pathogens.

The specific structure of the yeast fraction also enables it to 'communicate' directly with the immune cells located throughout the intestinal mucosa and help trigger a positive and satisfactory immune response. This interaction increases the capacity of the immune system to recruit mature and differentiated neutrophils which can identify and reduce pathogens faster and with less inflammation.

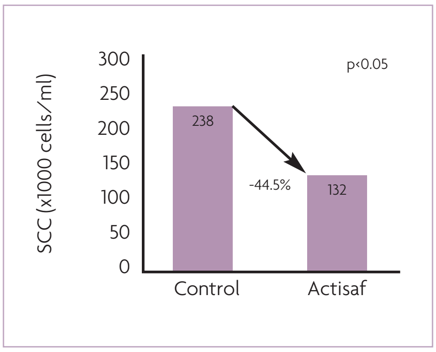

Fig. 1. Australian trial results.

Australian trial

With its unique metabolic effect, Actisaf can support the beneficial microflora in the small intestine and enhance the immune response, helping to maintain a low SCC.

A trial was carried out on an Australian dairy farm with 800 lactating Holstein cows. 88 cows in early lactation were split in two groups; a Treatment group which was fed a basal diet supplemented with 5g/c/d Actisaf and a Control group which was fed the basal diet only. Milk yield and milk fat were seen to increase significantly, and SCC reduced significantly, by more than 44% (Fig. 1).

Satisfactory immune response

To complement the effects of Actisaf yeast probiotic, the selected yeast parietal fraction Safmannan, which has a specific surface structure thanks to its controlled production process, can interact with immune cells, helping to trigger a strong and satisfactory immune response.

In an in vitro study on LPS-challenged macrophages, Safmannan demonstrated a strong and swift immunomodulatory effect, measured by the levels of TNF-α produced by the macrophages (Fig. 2).

In comparison, non-purified dead yeast which has similar components but a different surface structure, does not trigger any immune response.

The immune response from Safmannan is stronger when faced by a challenge like LPS (lipopolysaccharide; an endotoxin produced by Gram-negative bacteria such as E. coli), stimulating a more appropriate reaction from the immune system and reducing inflammation.

Dutch trial

When Actisaf is combined with Safmannan at 8g/c/d, it reduces SCC even more. Eight Dutch dairy farms that had been feeding Actisaf for a long time supplemented their cows with an additional 8g/c/d Safmannan for a trial period. Three milk samples were taken from each farm before Safmannan supplementation, and three samples after. The SCC decreased over the trial period, from an average of 280,000 per farm to below 200,000 (Fig. 3).

Conclusion

The SCC is predominantly made up of immune cells which are present in the udder as a response to infection. High SCC levels are related to subclinical mammary gland infections – mastitis. Reducing the SCC in bulk milk has been shown to increase dairy farm profits significantly and is very often the difference between profitable farms and farms which make a loss.

There are many ways to work towards reducing a herd's SCC, including using pharmaceuticals, changing management and hygiene practices, and using modern probiotics and prebiotics to prime the immune system. No single method is sufficient in isolation, and a good program that combines different practices can help reduce SCC and optimise milk performance.

Whatever program is set up on the farm to reduce SCC, adding probiotics to the diet that modulate the immune response increases the likelihood of success. ■

Fig. 2. The immunomodulatory effect of Safmannan.

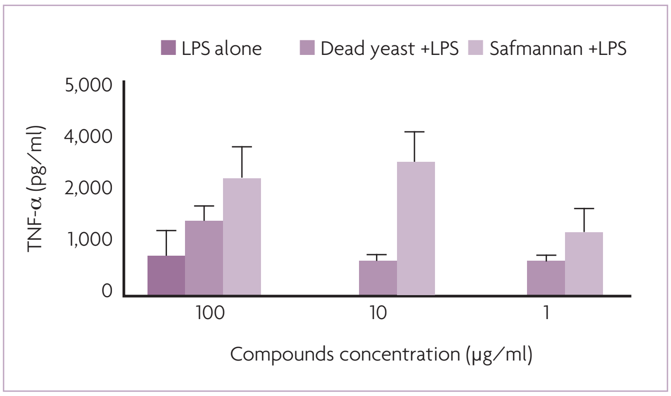

Fig. 3. Dutch trial results.