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Science & Solutions

Mycotoxins, Mastitis and Milk

Photo: Colleen Butler

Hidden Health Threats of Upsizing

Photo: fotostorm

What's Wrong with My Herd?

Part 2: Endotoxins

Editorial

Higher Temperatures and Bigger Units

The summertime is over and, as predicted, temperatures recorded in many regions –including the US, Middle East and South Europe– were well above average. In the US alone, heat stress costs the dairy industry approximately US$1 billion each year.

Dairy cows are particularly sensitive to heat stress due to the heat generated during milk production and rumen fermentation. More heat and humidity also means that feed and silage may contain higher amounts of harmful mycotoxins. In this issue of **Science & Solutions** we explore how mycotoxins can aggravate mastitis.

Diets lower in neutral detergent fiber (NDF) can be used to limit rumen fermentation heat—though the resulting rumen pH drop may make cows more susceptible to endotoxins. We detail tips against endotoxins on page 9.

Finally, mycotoxins and endotoxins are just two of the issues that farms encounter during upsizing. The global trend of more cows per herd comes with hidden health threats that jeopardize the economics benefits. On page 6 we look at common difficulties and offer tips to minimize disease during expansion. We hope that this information helps you to maintain healthy, high performing and profitable herds.

Enjoy the reading.

Zanetta CHODOROWSKA
Ruminant Technical Manager

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Mycotoxins, Mastitis and Milk

By **Paige Gott**, Ruminant Technical Manager

Mastitis is hard on cows and a major cost for dairying. Here we explore the links between mycotoxins and mastitis, and the effects on the quality and production of milk.

Mastitis is one of the most costly diseases of dairy cows globally. The estimated annual cost to the US dairy industry alone is $2 billion. While the causes and management of mastitis are complex, mycotoxins should be considered as they increase the risk of mastitis and can have negative impacts on milk production and milk quality.

The Types of Mastitis

Mastitis is an inflammation of the mammary gland which is generally associated with intramammary infection by microorganisms. Bacteria are the most common microorganism involved, but other agents can include fungal species (yeasts or molds), certain microscopic algae and viruses. Physical trauma or chemical irritation can occasionally cause mastitis.

There are multiple ways to classify cases of mastitis. The first major classification has to do with the origin of the pathogen: contagious vs. environmental (*Table 1*). Contagious pathogens include *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma* spp. Common environmental pathogens include *Escherichia coli*, *Klebsiella* spp., and environmental streptococci such as *S. uberis* and *S. dysgalactiae*. There are many other microorganisms that have been isolated from cases of mastitis. Coagulase negative staphylococci (CNS) are normal flora on the skin of the cows and these organisms can act as opportunistic pathogens when they enter the mammary gland. A hot topic in the world of mastitis research revolves around differentiating CNS to better understand the differences in their effects on milk quality and yield.

The distinction of acute vs. chronic mastitis has to do with the timing and duration of the disease (*Table 2*). Clinical and subclinical mastitis deal with the presentation of the disease. Clinical cases are easy to identify due to the visible changes in the milk and potentially the mammary gland. Subclinical cases often go unrecognized without monitoring of somatic cell count (SCC) or bacteriological culturing of milk. The different mastitis classifications are not mutually exclusive. For instance, a cow could have an acute clinical case of environmental mastitis.

Table 1. Contagious and environmental mastitis.

	Contagious mastitis	Environmental mastitis
Reservoir	Infected mammary glands	The cow's environment, including: • Bedding/stalls/soil • Manure • Water
Exposure	Spread from cow-to-cow, including via: • Milking equipment • Milkers' hands or towels • Flies and other vectors	Constant exposure exacerbated by heat and humidity

Source: BIOMIN

Table 2. Signs of acute and chronic mastitis.

Acute mastitis	Chronic mastitis
Sudden onset, but often quickly resolved	Continues over a long period of time
Redness, swelling, hardness	Often subclinical
Pain	Potentially painful
Grossly abnormal milk	'Flare-ups' or periodic acute events
Noticeable decrease in milk yield	Less obvious decrease in milk yield

Source: BIOMIN

Mastitis Costs

Economic losses stem from reduced milk production and decreased milk quality. Farmers must discard milk from cows with clinical cases of mastitis and from cows undergoing antibiotic treatment (according to withdrawal periods which provide time for antibiotics to clear the cow's body). Mastitis also alters the composition and properties of milk which reduces cheese yield and can reduce shelf life of manufactured products. Treatment costs and veterinary costs rise, as do labor costs, and milking parlor efficiency can decrease due to increased time spent attending to mastitic animals. In

Mycotoxins increase the risk of mastitis and can have negative impacts on milk production and milk quality.

addition to economic losses, animal welfare is a concern as studies have shown that mastitis can be painful and cause discomfort to cows.

Thus cows diagnosed with clinical mastitis, or those with persistent subclinical mastitis have a greater risk of being culled. Indeed, udder health issues are frequently cited as one of the top three reasons for culling of dairy cows. Low milk production, potentially associated with mastitis, is another leading cause of culling in dairy herds. Toxic mastitis, an acute form of the disease resulting in severe inflammation and septicemia, can even lead to cow death.

Predisposing factors

Table 3 outlines predisposing factors of mastitis. Proper milking parlor management and milking routine are essential to limiting mastitis risk in a herd. The milking system must be well maintained to ensure properly functioning, clean equipment is used to harvest milk. The pressure of the milking system and the duration of milking must be optimized as over-milking can damage the teat end, increasing the likelihood of mastitis.

Insufficient milk removal can also predispose cows to mastitis and may decrease overall milk production.

Mastitis is an inflammation of the mammary gland generally associated with intramammary infection.

Surfaces and alleys moving into the parlor as well as the holding pen must provide firm footing and cow flow should be smooth (a combination of good design and stress free handling) thus reducing the risk of physical injury to teats. Coordinating the delivery of fresh feed while cows are in the parlor will entice cows to eat and remain standing upon return to the pen. This provides time for the teat ends to close and limits exposure to pathogens following milking.

Good hygiene in the stall is also essential to reducing mastitis risk. Clean sand bedding is considered the gold standard, as inorganic material does not support the growth of pathogens. The greater the organic content of the sand; the less protective it will be. Nutrition can also play a role in mastitis risk. Cows in negative energy balance, especially transition cows, are more susceptible to infection. Diets must also meet vitamin and mineral requirements for proper immune function.

The environment plays a large role in mammary health. Increased temperatures and humidity better support pathogen growth in the cow's environment as well as increase stress in the cow, reducing her resistance to infection.

Mycotoxins

Mycotoxins can suppress the immune system of animals. Cows experience a great deal of stress around parturition due to the many physiological changes which occur with calving and the onset of lactation. Mycotoxins can exacerbate this stress via immune suppression and decreased feed intake, deepening negative energy balance and increasing the risk of metabolic disorders and infectious diseases. Deoxynivalenol (DON) and other trichothecenes can disrupt protein synthesis which can reduce white blood cell populations and condition and limit production of important inflammatory mediators. In addition, some of the ergots and trichothecenes can cause dermal lesions and gangrenous necrosis that disrupt the integrity of the teat and the teat skin, contributing to an increased risk of mastitis.

Paige Gott
Ruminant Technical Manager

Table 3. Predisposing factors of mastitis.

Milking equipment
Teat end damage
Over-milking
Genetics • Resistance • Mammary structure • Age
Management • Milking routine including pre- and post-dip application • Hygiene – milking parlor and barn • Bedding • Nutrition • Vaccination program • Dry cow therapy and transition cow management • Heifer management
Environment
Immune suppression • Transition cows • Mycotoxins

Source: BIOMIN

Table 4. Potential mammary-related negative effects of mycotoxins in dairy cows.

1.	Reduced milk production
2.	Toxic contaminants in milk, especially Aflatoxin M_1
3.	Increased risk of mastitis
4.	Altered milk composition

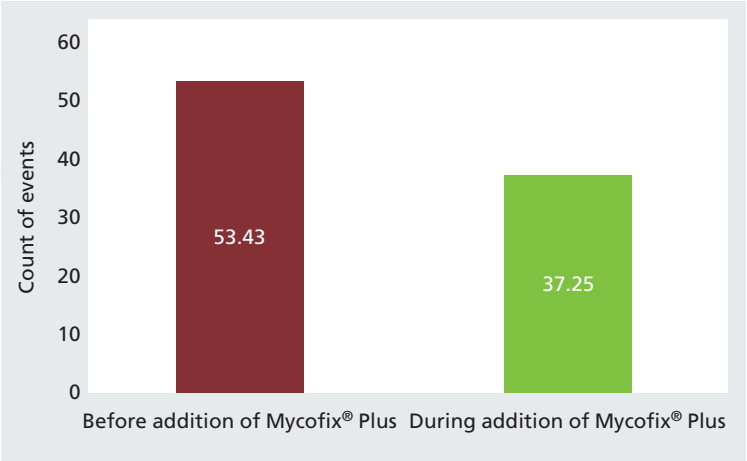
Source: BIOMIN

Table 4 highlights some of the main consequences of mycotoxins in dairy cows in relation to mammary health and milk production. Reduced milk production results from several factors, including a decrease in intake or feed refusal that is commonly reported with certain mycotoxins such as DON. Mycotoxins can alter rumen function by changing the microbial populations or the breakdown of nutrients, consequently reducing nutrient absorption and impairing metabolism which ultimately leads to reduced availability of the precursors needed for milk synthesis.

Reduced milk quality stems primarily from increased SCC. Somatic cells, specifically neutrophils, increase in number in the mammary gland during mastitis to combat invading pathogens. Mycotoxins can reduce neutrophil function, making the cow's immune response less effective which in turn increases the severity and duration of infection. Additionally, mastitis causes alterations in the concentration of milk components including changes in fat, protein, lactose, and mineral content. Compared with milk from healthy cows, mineral changes include increased sodium and reduced potassium levels. These differences negatively impact the manufacturing quality of milk. Milk processors want to obtain the highest quality milk to improve the yield and shelf life of manufactured products such as cheese.

Potential toxic residues in milk are another concern. The mycotoxin of greatest concern is aflatoxin B_1 which has been shown to result in 1.8 to 6.2 percent carryover from the diet to aflatoxin M_1 in milk. Aflatoxins are carcinogenic and most countries set strict limits on allowable levels in milk.

Figure 5. Mycofix Plus and the incidence of mastitis.



Source: BIOMIN trial in Slovakia, 2011

Solution

Feed should be monitored for the presence of mycotoxins and an effective mycotoxin counteracting product should be incorporated into the feed. Mycofix® contains an EU authorized aflatoxin binder, the only product to have been successfully evaluated through the EU registration process for aflatoxin deactivation. For the less adsorbable mycotoxins such as DON that pose an increased risk of mastitis and other challenges, biotransformation rather than binding is the effective approach. Mycofix® has proven biotransformation activity on DON and other trichothecenes, zearalenone (ZEN), ochratoxin A and fumonisins. In addition, Mycofix® bioprotection components support the liver and immune system. *Figure 5* shows how dairy cows (exposed to DON and ZEN in their feed) had a reduced incidence of mastitis when receiving Mycofix® Plus. Considerable data shows that Mycofix® can increase milk production, decrease somatic cell count, reduce toxic contaminants in milk, and help maintain or improve milk component content in the face of mycotoxin contamination.

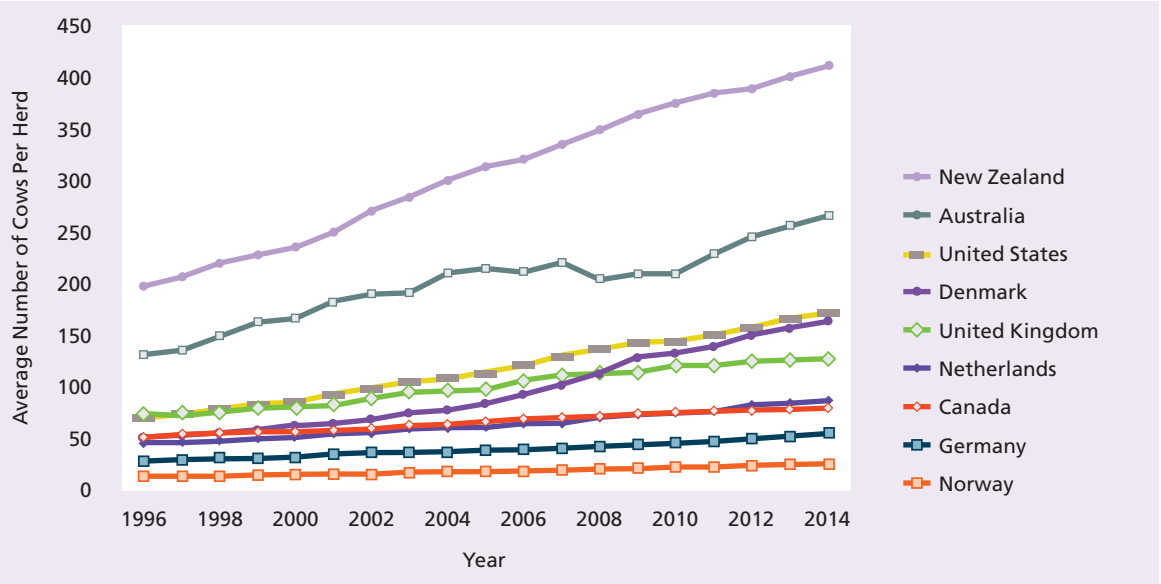
Hidden Health Threats of Upsizing

By **Zanetta Chodorowska**, Ruminant Technical Manager

The recent global trend towards larger herd sizes comes with unexpected health risks, requiring enhanced management and prevention efforts to glean the benefits of greater efficiency.

Economic pressure, evolving consumer expectations and the end of European milk quotas have reshaped the modern dairy farm. The dairy sector is experiencing a continuous process of upsizing for which the same number of animals in each region are managed in larger units (*Figure 1*). The efficiencies captured due to better utilization of capital

Figure 1. Average size of dairy cattle herds in selected countries.



Source: Barkema et al. 2015

and manpower can boost total milk output and offer a more stable cash flow. However, managing more cows requires increased technical competence and the right tools to maintain high per cow milk production, reproductive performance and health.

The bigger, the weaker?

Several recent scientific papers show that upsized and bigger farms have an increased health risks (*Table 1*). A major reason is the increased burden for the immune system. Different stressors act on it from new animals, different structures, changed management and often a new labor forces.

Mixing of cows of different origins also means mixing pathogens. Infectious diseases spread is a major reason for treatments and removals of cows during expansion. This can happen even if new animals and those already in the receiving farm have been vaccinated for the same diseases.

Photo: RimSlok

Table 1. Association between herd size increase and diseases.

Correlation with herd size	Health issue	Country	Reference
+++	Q fever	Portugal	Anastacio *et al.* 2014
++	Bovine Tubercolosis	Northen Ireland	Doyle *et al.* 2014
+++	Johne's disease	USA	Wolf *et al.* 2014
+++	*Coxiella brunetii*	Denmark	Agger *et al.* 2013
++	*Diarrhea*	Austria	Klein Jobstl *et al.* 2015
++	Johne's Disease	Ireland	Kennedy *et al.*. 2014
++	*Salmonella*	USA	Fossler *et al.* 2005
+++	*Besnoitia besnoiti*	Jordan	Talafha *et al.* 2015
+++	BVD; IBR; PDD; *Salmonella*; *Clostridiosis*	USA	Faust *et al.* 2001
++	Laminitis	UK	Whitaker *et al.* 2000

Source: BIOMIN

Table 2. Good Management Practice to minimize diseases during expansion.

Biosecurity
• Screen animals for diseases before purchasing in order to minimize risk of introduce cows harboring diseases like BVD, IBR, John's Disease, etc.
• Use culturing of milk in new animals to avoid cows that can carry contagious mastitis pathogens
• Isolate new arrivals for three weeks, prior to adding to the herd. It will help in preventing violent outbreak of diseases
• Establish a vaccination protocol. Vaccinate the new animals before their arrival and make sure there is a good vaccination antibodies levels of the cows in the receiving farm
Nutrition
• Have a proper mycotoxins risk management program as mycotoxins can directly weaken immune systems making animals susceptible to diseases.
• Provide a sound micronutrient and vitamins supplementation to boost the immune cells activity
• Provide balanced ration in order to avoid any risk of Sub Acute Ruminal Acidosis (SARA)
Management
• New cows should be milked last to reduce the chance of transferring new pathogens to the previous cow population
• Limit any source of stress like overcrowding and unnecessary mixing and regrouping
• Train new hires to have a friendly approach to animals

Source: BIOMIN

Mycotoxins

In addition, failure to act on the key parameters of health and fertility can jeopardize overall farm profitability. A perfect example are mycotoxins, as they impact the immune system, laminitis and inflammation. Larger farms tend to use more acidogenic diets which increase the passage rate and reduce natural detoxification of mycotoxins inside the rumen, exposing cows to harm.

Additionally, a higher starch diet can predispose animals to Sub Acute Ruminal Acidosis (SARA).

Bigger farms are the future of modern milk production, but efficiency and health only fit together if producers master the details.

Endotoxins

Endotoxins are fragments of the external cell wall of Gram-negative bacteria that can be produced during microbial growth, replication or death. SARA is one of the situations that can generate a flush of endotoxins inside the cows' rumen as it is associated with extensive bacterial death.

However, endotoxins challenges can arise from many situations quite common during herd upsizing including antibiotic treatments, metritis and mastitis. A rise of circulating endotoxins can generate liver toxicity, hyperthermia and inflammation. Decreased liver health is a condition that favors ketosis which in turn can predispose the animal to a weaker innate immunity. Recently, Reisinger *et al.* (2015) demonstrated that endotoxins are related to laminitis as their increasing doses exhibits a negative influence on lamellar tissue integrity of cultured hoof explants.

Big, health herds

Bigger farms are the future of modern milk production, but efficiency and health only fit together if producers master the details. Any additional challenges that impair immune function can mean real setbacks for productivity. To be successful, producers must remain focused and target four main actions:

- Biosecurity
- Workers education
- Animal fluxes
- Checking for hidden risks

Good protocols of biosecurity to deal with infectious diseases, worms, mastitis and lameness are compulsory to minimize the impact of all the changes on cow health experience. Nevertheless immune system remain under pressure even when good management practices are applied (*Table 2*).

Cut & Keep Checklist

What's Wrong with My Herd? Part 2: Endotoxins

Endotoxins, or lipopolysaccharides, comprised of a fat (lipid) and starch (saccharide) components are remnants of the cell walls from Gram-negative bacteria such as *E. coli* and *Salmonella*. They are released upon the bacteria's death and increase when conditions are such that cause increased cell death of these bacteria. Common causes of endotoxin exposure in cows include antibiotic feeding and subacute rumen acidosis (SARA).

Endotoxins cause strong inflammatory reactions and are classically used in research to invoke a fever situation. LPS acts by binding to key receptors in many cell types, but especially in monocytes, dendritic cells, macrophages and B cells, which promotes the secretion of pro-inflammatory cytokines, nitric oxide and eicosanoids. Interestingly, cattle may not exhibit a fever response to either very high or very low endotoxin administration, though a lack of fever, at least in cattle does not mean that there has not been a release of, and an effect of, endotoxins.

Harm to cattle

Endotoxin effects in cattle are closely associated with both rumen acidosis and subacute rumen acidosis (SARA). SARA is a common condition in feedlot cattle and lactating dairy cattle that are receiving diets with increased energy from a grain source. SARA conditions can result in not only the lysing of Gram-negative bacteria but also can result in lowered rumen wall integrity. This combination can result in the passage of bacteria such as *Fusobacterium necrophorum* associated with liver abscesses, and increased absorption of endotoxins.

Attacking the liver

Perhaps the greatest detrimental effects of endotoxins on performance are due to the effects on the liver. The liver is the primary organ responsible for the removal of toxins from many sources including plant poisons, mycotoxins, and endotoxins. Kupffer cells are specialized macrophages that are responsible for removal of endotoxins. They are also responsible in large part for the cascade of inflammatory events. The liver is an extremely active organ with many functions. In addition to the detoxification and immune related functions, the liver is important for the production and repackaging of nutrients such as proteins, carbohydrates and fats. An impaired liver will result in reduced nutrient availability and reduced production.

Time around parturition

Cows are in negative energy balance with requirements for both glucose, much of which is produced in the liver and fats which are repackaged for distribution to tissues via VLDL excreted from the liver. It is common to see increased fat accumulation in the liver near parturition. The condition may become severe enough, resulting in "fatty liver" syndrome which is associated with decreased liver functions including the reduced production of glucose leading toward ketosis. It is also found that livers with increased lipid content do a poorer job of clearing endotoxins from the blood allowing for greater endotoxin concentrates to circulate to other tissues7.

Table 1. Negative effects of endotoxins in cows.

Reduced rumen motility associated with: • Decreased fiber digestion • Lower rumen pH • Increased chance for displaced abomasum
Increased mastitis, metritis
General immune suppression
Liver impairment associated with: • Reduced nutrient availability • Reduced production
Higher rate of respiration

Source: BIOMIN

Table 2. Tips to counter endotoxins.

Prevent decrease in rumen pH through: • Careful selection of feed ingredients • Potential use of buffers
Avoid abrupt feed changes from fiber to grain based diets
Use a feed additive able to bind endotoxins and support liver and immune function

Source: BIOMIN

Prevention and mitigation

Producers can reduce their risks of endotoxicosis through management and key feed additives. The levels of endotoxin increase with decreased rumen pH. Maintaining stable rumen pH through selection of feed ingredients and potential use of buffers should decrease this risk factor. Additionally LPS challenges were worse in abrupt feed changes from fiber to grain based diets. Additionally certain mycotoxin products designed to adsorb aflatoxins and ergot alkaloids may also bind endotoxins. However not all products will have affinity for LPS and care should be taken to select products that have been tested and demonstrated to adsorb endotoxins. With good management and adequate feed composition your cows can overcome critical states in good conditions.

For more information, visit **www.mycotoxins.info**

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