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Nutritional strategies to manage stress in cattle discussed

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THE phrase "during times of stress" is used regularly to describe the physiological and nutritional challenges of transition periods.

Typical times of stress in dairy cows include from late pregnancy through parturition, weaning and early lactation, and in beef cattle, transitional challenges include the receiving phase, diet "step-up" changes and the finishing phase. Environmental challenges can also contribute to increased stress levels, with the high-temperature humidity index leading to heat stress load on animals.

Production demands on top of the negative physiological impacts of stress can result in an increased incidence of metabolic disorders and reduced immune function. These factors, combined with reduced dry matter intake (DMI), make stress a significant cause of economic loss as a result of reduced production and increased morbidity and mortality.

While the industry has traditionally focused on investing to increase performance, more producers are starting to recognize the importance of mitigating against the negative economic impacts of stress, investing in management and nutritional practices that support effective functioning during these phases.

Heat of summer

The summer months often bring unavoidable heat stress that affects both dairy and beef cattle. The ability to regulate body temperature is species and breed dependent; however, dairy breeds are generally more susceptible to heat stress as they generate greater metabolic heat (Bemabucci et al., 2010).

Increased rectal temperature and respiration rate are commonly associated with heat stress and often accompanied by a drop in DMI — a factor that can lead to reduced production. Feed intake-independent shifts in post-absorptive glucose and lipid homeostasis may also contribute to further reductions in production (Wheelock et al., 2010).

In addition, dairy cattle spend less time lying under heat stress conditions (Shiao et al., 2011).

Heat stress has an impact on feeding behavior, with both beef and dairy cattle eating smaller but more frequent meals during the day and increasing intake during the cooler night.

These changes in feeding patterns, combined with other behaviors such as selection of grains over forages due to lower heat production during digestion, can lead to changes in the rumen that predispose the animal to metabolic conditions such as sub-acute ruminal acidosis (SARA)/acidosis. Changes in the rumen, including a reduction in motility and an increase in rumen temperature,

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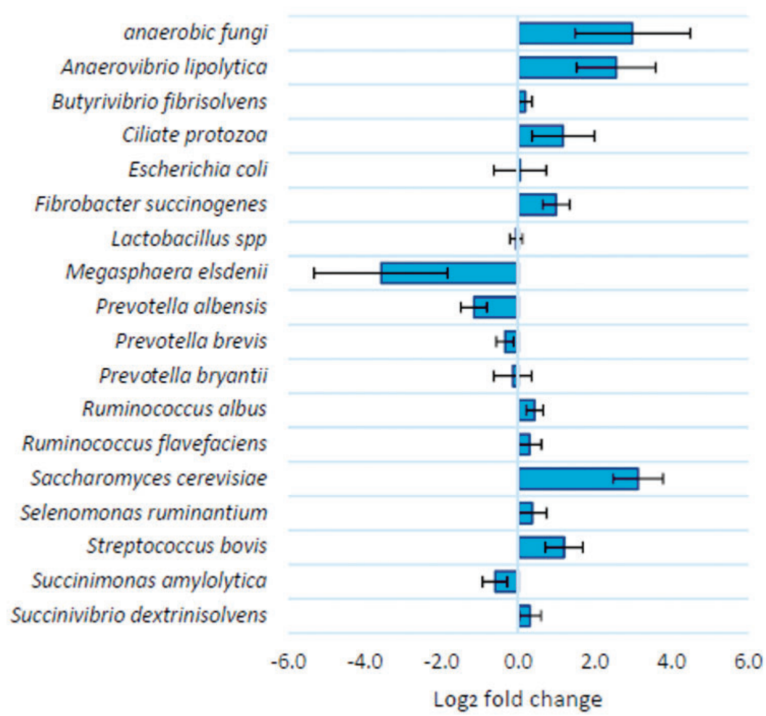
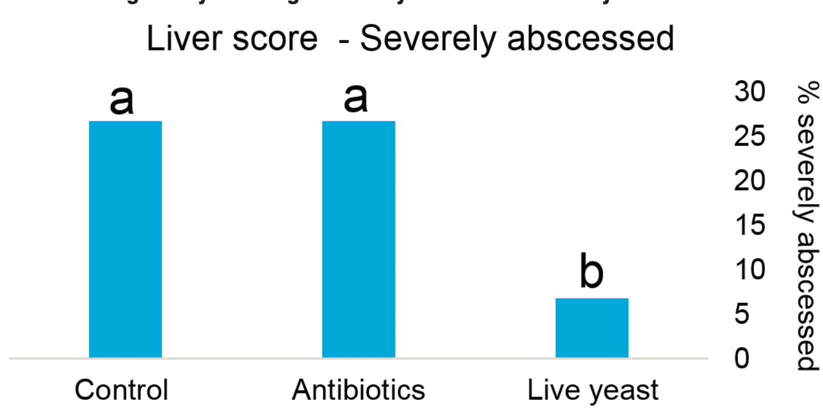
1. Change in rumen microbe numbers when feeding a live yeast following SARA challenge



Source: AlZahal et al. (2017).

2. Feeding live yeast significantly reduced severely abscessed livers



Note: Differences in letters indicate a significant difference of $P < 0.05$.

may also lead to reduced and altered volatile fatty acid production during a heat stress challenge, resulting in a decrease in the acetate-to-propionate ratio.

While improvements in farm infrastructure in the form of enclosed sheds and fan ventilation have helped reduce the impact of heat stress on some dairy units, beef feedlots often do not have the same opportunity to mitigate losses associated with heat stress through management factors alone due to the size and structure of their operations.

Price of heat stress

Annual costs of heat stress are estimated at approximately $900 million for the U.S. dairy industry and $370 million for the beef industry (St-Pierre and Schnitkey, 2003). While those numbers are unmistakably large, it is important to consider the costs to the individual producer.

For a dairy cow producing 90 lb. of milk with 50 lb. of DMI, a 10% loss in milk production would result in a reduction in the income over feed cost (IOFC) of approximately 16% (assuming a milk price of $16.5/cwt. and a feed cost of 12 cents/lb. of dry matter). In a 4,000-head milking cow herd, the loss of IOFC is in the region of $500,000 per day based on milk volume alone. Depressed DMI will account for some cost recovery, but not nearly enough to protect against the lost milk revenue.

Nutritional strategies

Cattle suffering from heat stress exhibit physiological and metabolic changes that result in higher maintenance requirements (Bernabucci, 2012). Using the Cornell Net Carbohydrate & Protein System (CNCPS) models, a dairy cow weighing 1,400 lb. and producing 80 lb. of milk per day requires 22% additional energy to meet the requirement at 90°F as opposed to 60°F (Chase, 2006).

Nutritional strategies to reduce the impact of heat stress include improving the quality of proteins fed or feeding rumen undegradable protein and increased levels of essential amino acids, methionine and lysine. Bypass fat that does not have a negative impact on microbial growth in the rumen is an excellent way to increase net energy intake due to its high energy density and lower metabolic heat.

Feeding fiber needs to be carefully managed because the metabolism of acetate produces more endogenous heat than propionate. Acetate production increases from a high-fiber ration and results in a slower, more stable fermentation, whereas more propionate is produced from high-starch/low-fiber diets and results in a faster, less stable fermentation that leads to a shift in the rumen microbiota away from fiber-fermenting microbes. In an optimal situation, the acetate:propionate ratio should be greater than 2.2:1.

With limited DMI, there is a temptation to increase the highly fermentable carbohydrate portion of the ration to maximize the net energy intake. In the short term, this will be effective. However, it can be costly in terms of diet cost and also of the rumen microbial population and the risk of acidosis.

An alternative approach is to feed a ration that results in an optimal acetate:propionate ratio, keep control of ration costs and utilize live yeast to optimize the rumen environment for fiber fermentation.

The addition of live yeast to the ration can also help counter the negative impact on rumen function that results from the previously described changes in feeding behavior caused by heat stress via the probiotic effect it exerts on the rumen microbiome.

A combination of factors that include the ability of live yeast to scavenge oxygen — thus creating an environment that favors the proliferation of fibrolytic bacteria — along with competition for sugars with lactate-producing bacteria, creates a rumen environment that favors efficient fiber digestion while supporting a neutral rumen pH (Krizova et al., 2011), a factor associated with a reduced risk of rumen dysfunction.

The rumen microbiome is sensitive to a drop in pH, which is particularly apparent during SARA or acidosis. Feeding live yeast following a SARA challenge has an impact on the rumen microbial population, bringing improvements in functional microbial groups. Figure 1 shows the effect of feeding a live yeast after a SARA challenge, with increased numbers of fiber-digesting bacteria, including *Fibrobacter succinogens*, *Ruminococcus albus* and *Ruminococcus flavefaciens*. Organisms associated with helping stabilize ruminal pH, such as *Selenomonads* and ciliate protozoa, also increased. Numbers of *Megasphaera elsdenii*, a lactate-utilizing bacteria, were reduced, suggesting a reduction in rumen lactate (AlZahal et al., 2017).

Optimizing ruminant capabilities

Often, the easiest way to explain ruminant nutrition to a layman is to say that "nutritionists feed the bugs, and the bugs feed the cow." The rumen — and the microbial population living within it, when managed well — is the key to animal performance. Feed ingredients that work side by side with rumen microbes offer a best-practice approach to optimizing animal performance and achieving profitability.

Optimizing the rumen environment for the greatest fiber fermentation should always be high on the list of priorities for a ruminant nutritionist. However, this becomes a challenge when increasing amounts of concentrates are fed in response to the demands of production. Rumen pH fluctuates throughout the day, particularly around feeding, and cellulolytic bacteria are sensitive to low pH (Newbold et al., 1996).

The change in pH has an impact on the microbial population, with high-starch beef finisher diets causing a shift in the microbial population toward a high number of proteobacteria, which are well adapted to rapidly fermentable carbohydrates (Fernando et al., 2010). These adaptations in the rumen microbiome in response to high-starch diets can result in a rumen environment that becomes increasingly acidotic, predisposing the animal to a number of digestive disorders that can negatively impact performance and profitability.

Digestive disorders are among the biggest cost to production in beef systems, affecting profitability due to cost of treatment, reduced average daily gain (ADG) and more days on feed.

Conditions such as ruminal acidosis and frothy bloat contribute to a loss of live weight gain of 7-15% (Malafaia et al., 2016). Cattle with diagnosed acidosis at slaughter have been reported to have an average loss in daily gain of 0.57 lb. per day. The presence of parakeratosis (damage to the rumen papillae, which results in a smaller area for absorption) at slaughter has been associated with an average loss of 0.35 lb. in daily gain.

Liver abscesses are a particular challenge for the beef industry. They arise from ruminitis and acidosis as a result of feeding high-starch diets, and they can be associated with a loss in ADG of up to 14% and a loss in the gain:feed ratio of up to 13% (Brown and Lawrence, 2010).

In a recent study by Ran et al. (2018), live yeast was shown to reduce the number of severely abscessed livers versus the control and a monensin/tylosin treatment (Figure 2).

Feeding the immune system

Nutritionists are well aware of requirements, be they for maintenance, growth or milk yield. However, recent years have brought scientific understanding that the immune system has a nutritional requirement as well. It has been suggested that, in order to maintain an active immune response for 12 hours, a lactating Holstein cow requires more than 2.2 lb. of glucose (Kvidera et al., 2017).

Stress can have an effect on the immune system, reducing its functionality, while the production of stress hormones can also enhance the virulence of enteric pathogens (Freestone and Lyte, 2010).

Stress hormones can act as potent stimuli for the attachment of bacteria to bovine gastrointestinal tissues (Bansal et al., 2007). Even mild stress situations, such as weighing cattle, can increase colonization and fecal shedding of enteric pathogens such as salmonella and *Escherichia coli* (Freestone and Lyte, 2010).

Both live yeast and yeast cell wall

products are able to bind to bacterial pathogens, resulting in the limitation of attachment to intestinal cells. The cell wall of live yeast is typically comprised of approximately 85% polysaccharides — primarily mannans and glucans — and 15% proteins. The mannoproteins partly form the outer layer of the yeast cell wall and have the ability to bind to bacteria (Lesage and Bussey, 2006).

Live yeast, in addition to the mode of action of the cell wall components, is thought to help prevent bacterial colonization through competitive inhibition or direct antagonism (Shoaf-Sweeney and Hutkins, 2009).

In a study by Posadas et al. (2017), live yeast products had an overall greater adhesion than yeast cell wall products to 13 bacteria that were tested. The ongoing work on the use of live yeast and yeast cell wall products provides an interesting insight into how these products may also be combined with other dietary and management factors to help support immune function during times of stress.

Double-pronged attack

The pressure to keep control of ration costs and maximize the performance of beef and dairy cattle is only increased in the volatile markets of today. Times of stress, including both transitional periods and environmental stress, can seem like unavoidable costs to both the beef and dairy industries.

However, nutritional management and, in particular, careful management of the rumen during times of stress offer the potential to reduce the losses through helping to stabilize rumen pH and microbial populations. Ruminant nutritionists have the possibility to work with the rumen microbial population to overcome challenging times.

Choosing to feed a live yeast provides a double-pronged approach to maximizing the benefit of a feed ingredient to help in times of stress. The probiotic mode of action optimizes the rumen environment, bringing improvements in fiber fermentation and, ultimately, helping maintain animal performance at times of stress. Live yeast also has the potential to be used in reduced-antibiotic diets due to its ability to bind to pathogens, stimulate the immune system and act as a competitive inhibitor to pathogenic bacteria.

References

References are available on request from nam@abvista.com. ■