Managing heat stress in dairy cows

by Bruno Rochet and Marina Mazzia, ruminant technical manager, Lallemand Animal Nutrition, 19, rue des Briquetiers, BP 59, Blagnac Cedex, F-31702, France.

Dairy cows are very sensitive to heat stress, which has a significant economic impact for the farmer: not only loss of productivity and milk quality (somatic cells count), but also health related problems.

The farmer is usually aware of some of the essential herd management practices necessary in this critical period, however some nutritional solutions may not be as well known.

In particular, probiotics, which, by improving rumen conditions and functions affected by the stress factors, can help preserve the cow's digestive health, milk productivity and overall health status.

During heat stress periods, the oxidative balance is also affected and it is very important to increase the anti-oxidant intake in order to preserve the cows' immunity (mastitis prevention) and reproductive health.

Temperature and humidity

The severity of heat stress is correlated to both ambient temperature and humidity level (Fig. 1). The bovine thermal comfort zone is between -13 and +25°C.

Within this temperature range, the animal comfort is optimal, with a body temperature between 38.4 and 39.1°C.

Above 25°C, and even 20°C for some authors, the cow suffers from heat stress: its health status and zootechnical performance are affected.

How to evaluate heat stress:

- Body temperature (rectal) >39.4°C.
- Respiratory frequency >100/mn.
- DM intake decreases:
  - 10% = high stress.
  - 25% = severe stress.

The financial impact

Severe heat stress can induce financial losses of up to $550/cow.

An estimated 80% of these losses are associated with loss of productivity, and 20% with health issues: reproduction and immunity problems, which translate into increased mortality and mastitis frequency in particular (Table 1).

A disrupted energy balance

Bovines have two main ways of maintaining their thermal balance and regulating their body temperature under high heat conditions.

They rely essentially on both:

- Favouring heat dispersion, in particular through evaporation, by increasing subcutaneous blood flow, panting and drooling.

These activities increase the maintenance energy needs of the animal by an estimated 20% at 35°C. In the case of the dairy cow this means that part of its production energy will be redirected to thermal regulation.

- Limiting heat production by reducing all activity and changing its feeding pattern. Indeed, heat production in dairy cows is essentially due to rumen fermentations. The cow's DM intake can be reduced by 10-30%. Also, rumination, which produces heat, decreases dramatically. Cows will tend to eat less during the day, but more often and in small quantities.

They will tend to consume more feed at night when it is cooler, slug feed, sort feed and tend to choose feeds that produce less heat during

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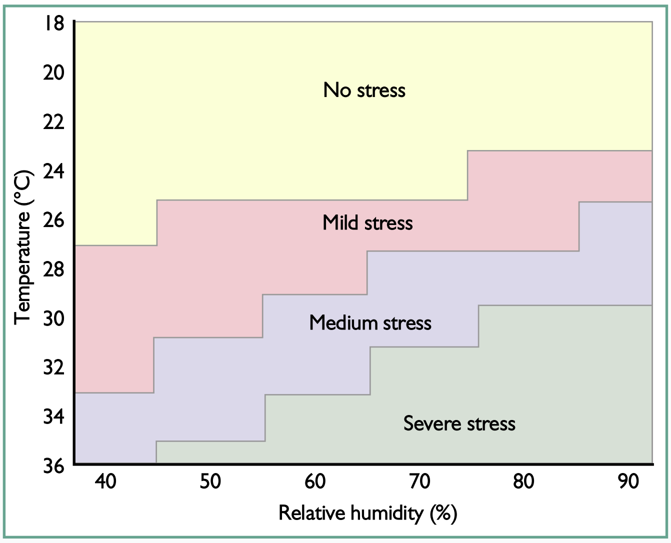

Fig. 1. To each temperature/humidity index corresponds a level of thermal stress (Modified from F. Wierama. University of Arizona. 1990).

Fig. 2. Heat stress, with its physiological and behavioural consequences, increases the risks of rumen acidosis.

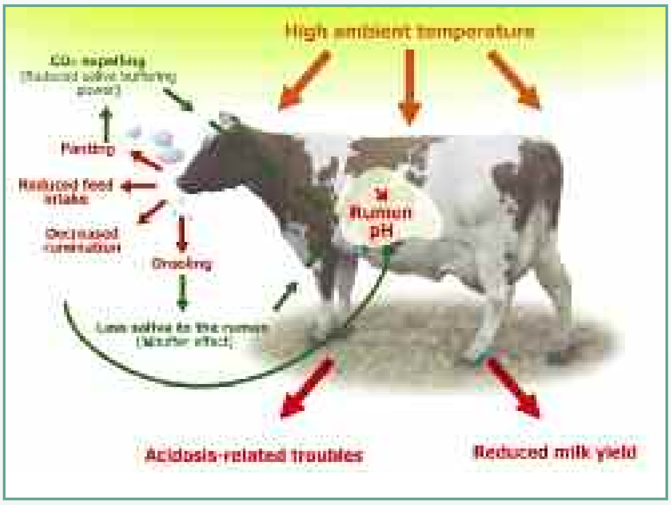

Table. 1. The economic impact of heat stress: estimates from a study conducted under severe heat stress conditions in Florida, USA (taken from St Pierre et al., 2003).

Heat stress consequence	Physiological impact (average)	Financial impact (average/cow/year)
DMI decrease: 6 to 30%	-894kg/cow/year	+$116
Milk production decrease: 15 to 20%	-1 803kg/cow/year	-$517
Reproduction efficacy decrease: 40 to 50%	+59.2 days from calving to conception	-$158
	+7.99% culling due to reproductive problems	
Mortality increase: 1.72%	+1.72% mortality	-$3
Increased mastitis incidence and severity		

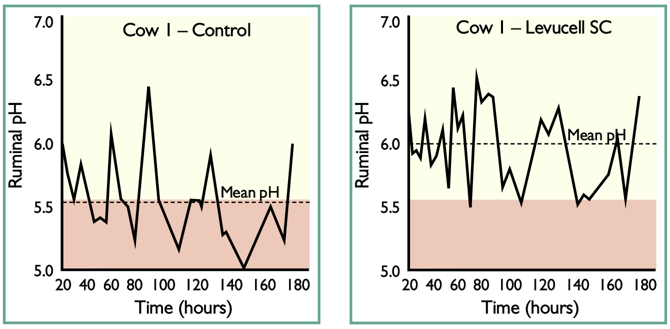

Fig. 3. The effects of Levucell SC on rumen pH variations with a high energy diet (In orange, the acidosis risk zone, where rumen pH< 5.6) (A. Bach, IRTA, 2007).

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digestion, choosing grains and proteins over forages.

Acidosis risks

In periods of heat stress, the risks of acidosis are increased. Factors that can contribute to rumen acidosis problems are: decreased DM intake with lower proportion of forage and higher levels of fermentable carbohydrates, decreased rumination, decreased saliva to the gut – a source of bicarbonate, with a reduction of its buffering power due to increased carbon dioxide expelled (panting) (Fig. 2).

Additionally, the decreased rumen pH impairs fibre digestion efficiency: rumen fibrolytic bacteria are the most affected when rumen pH drops (below 6.0).

All of these factors contribute to decreasing feed efficacy, and consequently, milk yield and often milk fat.

Moreover, acidosis is proven to affect the animal's overall health status, fertility, and longevity

Herd management

In order to prevent the effects of heat stress, keeping cows comfortable and as cool as possible are key.

Adequate fresh clean water must be provided at all times. Shade, fans, misters (in lower humidity areas) and coolers are very effective tools to help lower cow body temperature during heat stress periods.

It is also recommended to distribute feed more frequently. Feeding in the cooler times of the day and pushing up feed more often can also encourage more feed intake. In order to limit the physiological risks linked to heat stress and in particular rumen acidosis, the ration can be adjusted: high energy, more palatable diets, with high quality, highly palatable forages. In order to prevent acidosis, the ration can also be secured with ruminant specific live yeast. Finally, antioxidants intake should be increased.

Levucell SC

Levucell SC from Lallemand is a well identified ruminant specific live yeast (strain Saccharomyces cerevisiae CNCM I- 1077, deposited at Pasteur Institute).

This particular strain has been selected and validated by internationally renowned research centres (over 40 scientific papers). Three main mechanisms have been identified to explain its effects on ruminants' performance and health:

- Improved rumen pH: reduced acidosis risk.
- Improved fibre digestion and nitrogen utilisation: increased feed efficacy.
- Rumen microflora stabilisation.

More recently, Dr Alex Bach (IRTA, Barcelona) has shown Levucell SC's ability to improve dairy cows' rumen pH in different diet conditions (Figs. 3 and 4).

These studies also demonstrated a change in feeding behaviour: the average meal interval was reduced from four hours in control cows to three hours 20 minutes with Levucell SC.

Production trials, conducted in heat stress conditions, illustrate the statistically significant effect of

Table 2. The effects of Levucell SC on dairy cows milk production in summer trials (trials Lallemand, 2003-2004).

Trial	Period	Duration	Milk production
FARME Institute Inc. NY, USA (2004)	Summer (June-Aug 2004)	60 days	+ 7.2% + 2.7kg
Shanghai Zhenyuan Dairy Co, China (2003)	Summer (severe stress)	60 days	+ 7.1% + 2.0kg

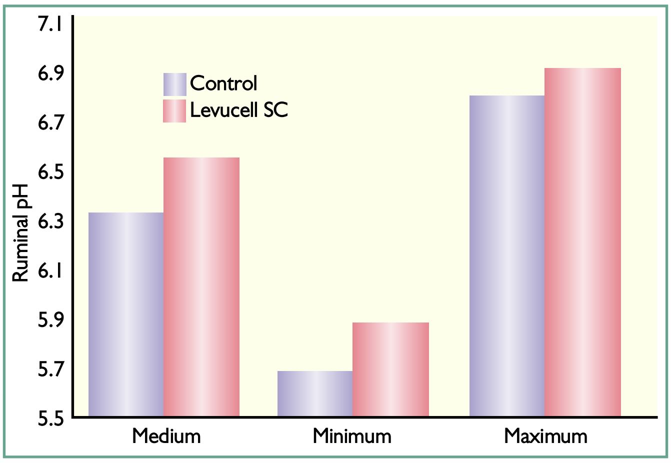

Fig. 4. The effects of Levucell SC on rumen mean, minimum and maximum pH in dairy cows (A. Bach, Minnesota University, 2007).

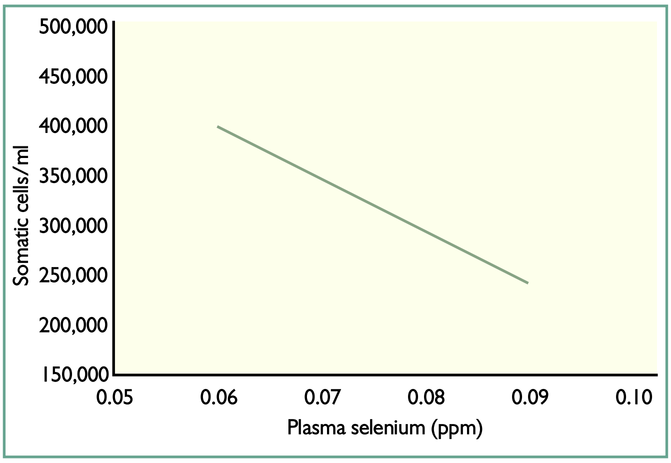

Fig. 6. High level of selenium in the plasma limits the number of somatic cells in milk (Weiss et al. 1990).

Levucell SC live yeast on milk yield (see Table 2).

In stress conditions, the addition of Levucell SC into the diet of dairy cows is a good strategy to prevent acidosis risks, optimise feed intake and reduce the negative impact of heat stress on milk production.

Heat and oxidative stress

Heat stress generally increases the production of free radicals, leading to oxidative stress.

The presence of free radicals leading to oxidative reactions in the organism is physiological.

It is a natural mechanism of defence against bacteria and is also involved in normal cell functions.

But these oxidative reactions must be kept under control, which is possible thanks to natural anti-oxidative mechanisms, based on two main principles:

- The neutralisation of free radicals. This is the case of anti-oxidants compounds, such as vitamins E, C, Q, polyphenols and carotenoids.
- The reduction (repair) of oxidised molecules, thanks to dedicated enzymatic systems, such as glutathione peroxidase.

This is the oxidative balance. Various stress factors, such as, heat, UVs, certain toxins, inflammation and infections can generate a disequilibrium of the oxidative balance, which leads to oxidative stress, with important consequences over the function, life and death of the affected cells.

In dairy cows, oxidative stress has a negative impact on immune and reproductive functions, including increased mastitis frequency and higher somatic cells counts in milk, decreased fertility, increased embryo mortality, post-partum retained placenta and early calving, with consequences on the calves' live weight, mortality and health (Table 3).

Parameter	Control	Stressed heifer
External temperature (°C)	21.1	32.2
Heifer rectal temperature (°C)	38.5	40
Respiratory frequency (mn-1)	47.3	105.3
Conception rate (%)	48	0

Table 3. Heat stress impact on heifer fertility (Piton, 2004).

The role of selenium

In many areas around the world, the soil, and thus the plants and forages are poor in selenium, long recognised for its antioxidative properties.

In particular, the glutathione peroxydases family of anti-oxidative enzymes, containing selenium incorporated within an amino acid (organic form), plays a major role in maintaining the anti-oxidative balance, protecting the cells from damage (Figs. 5 and 6).

It has been shown that the level of anti-oxidative activity of this selenoenzyme is intimately linked to selenium status and dietary intake, hence the necessity of supplementing the ration with selenium.

This is even more crucial during heat stress periods, when the oxidative balance is tilted.

Nutritional feed additive

Alkosel^{R397} is an organic selenium enriched yeast product (strain Saccharomyces cerevisiae NCYC R397) registered as a nutritional feed additive for all animal species within the EU.

The specific yeast strain in Alkosel has been selected for its ability to incorporate high levels of selenium as selenomethionine.

This is a form which is naturally present in plants and animals and thus far more bioavailable than the mineral form (selenite).

Trials have shown that dairy cows supplemented with Alkosel^{R397} increased selenium status in their blood, milk and colostrum, to higher levels than equivalent doses of mineral selenium.

Based on selenium anti-oxidative activity, Alkosel^{R397} is able to improve immune and reproductive functions, which are deeply affected by heat stress.

For example, it has been shown that organic selenium supplementation played a role in the prevention of retained placenta.

Milk quality can also benefit from Alkosel^{R397} supplementation: reduced somatic cells (Fig. 7), but also higher selenium levels, with obvious added benefits for the calf and the consumer alike, considering the overall low selenium intake in man in many regions. ■

Fig. 5. Vitamin E and selenium anti-oxidative activity.

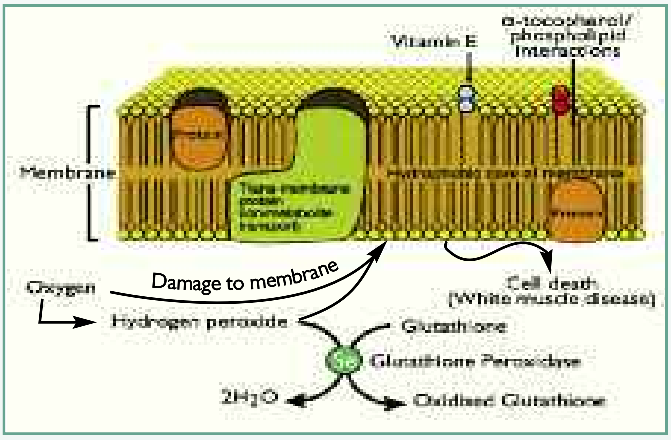

Fig. 7. Effect of Alkosel^{R397} treatment (0.2ppm organic Selenium vs. 0.2ppm sodium selenite in control) on somatic cells count in dairy cows. Trial performed in Estonia for a duration of eight weeks on 100 dairy cows in mid-lactation (Malbe et al. 1995).