Heat stress in dairy cows and the role of nutrition

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Technical support manager
Lallemand Animal Nutrition
Presentation

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1. Introduction
   - Threshold for heat stress

2. Negative impact of heat stress
   - Rumen health and feed efficiency
   - Oxidative stress

3. How to assess heat stress

4. Nutritional management
   - Practical solutions to combat heat stress
Lallemand: A passion for fermentation

Our core activity is the development, production and marketing of yeast, bacteria and their derivatives:
Responding to market demands

DIGESTIBILITY ENHANCEMENT

DIGESTIVE MICROFLORA BALANCE

IMMUNITY SUPPORT

NUTRITION AND WELL-BEING
Yeast and bacteria probiotics
Yeast derivatives
Antioxidants

FEED MANAGEMENT
Silage inoculants

ANIMAL ENVIRONMENT
Manure/slurry management
Biofilms
Bioremediation
Competitive Exclusion

Specific Applications

ANIMAL ENVIRONMENT

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Heat stress

- A common problem
  - In many parts of the world
  - More extreme weather conditions
  - Increasing production levels
  - Breeds from mild climates

- Underestimated impact
  - Even during short periods of heat stress
    - Immediate impact + recovery after heat stress period
Burgos and Collier, 2011

- Threshold for Dairy Cows: THI 68-72

Meteorological station can underestimate by 3 units the THI inside barns

Shock et al, 2016

<table>
<thead>
<tr>
<th>Temperature</th>
<th>°F</th>
<th>°C</th>
<th>% Relative Humidity</th>
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<tbody>
<tr>
<td>72</td>
<td>22.0</td>
<td>65</td>
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<tr>
<td>5</td>
<td>97</td>
<td>84</td>
<td>88</td>
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</tbody>
</table>

Temperature humidity index (THI)

Impact of heat stress on lactating dairy cow performance

<table>
<thead>
<tr>
<th>Practical examples of heat stress</th>
<th>[Temperature : Relative Humidity]</th>
<th>Duration (hours/day)</th>
<th>Milk loss under heat stress [kg/h; kg/cow/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress Threshold THI [68-71]</td>
<td>[22°C (72°F); 50%]</td>
<td>4</td>
<td>[-0.283kg/h; -1.1kg/cow/day]</td>
</tr>
<tr>
<td>Mild Moderate Stress THI [72-79]</td>
<td>[25°C (77°F); 50%]</td>
<td>9</td>
<td>[-0.303kg/h; -2.7kg/cow/day]</td>
</tr>
<tr>
<td>Moderate-Severe Stress THI II [80-99]</td>
<td>[30°C (86°F); 75%]</td>
<td>12</td>
<td>[-0.322kg/h; -3.9kg/cow/day]</td>
</tr>
<tr>
<td>Severe Stress THI [90-99]</td>
<td>[34°C (93°F); 85%]</td>
<td>Not measured</td>
<td></td>
</tr>
</tbody>
</table>

Burgos and Collier, 2011

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Burgos and Collier, 2011

Reproduction and耸reunderstanding - Japanese University
Introduction

Impact of heat stress

■ Decreased performance
  ■ Decreased milk production

■ Suppressed immunity
  ■ Reduced milk quality

■ Decreased reproduction
  ■ Reduced conception

■ Decreased welfare
  ■ Acidosis and lameness

■ Long-term effects
  ■ Subsequent lactation or offspring
What happens with the cow’s rumen health?

Impaired rumen health and risk for SARA:
- Rumen pH decreases below 5.8
- Milk yield, milk fat content and feed efficiency decreases
- Other consequences and symptoms lameness, mastitis, reduced conception rate
Reduced rumination activity

- For 10 points of difference of THI:
  Loss of 60 minutes of rumination time per day

Mathew Haan, Penn State Extension
Published 02/11/2016

Rumination
- Saliva production is decreased
- Bicarbonate is reduced → because of panting
- Ruminating is an indicator rumen motility → important for removal of SCFA
- Less rumination will again have a depressing effect on feed intake

Lallemand internal database/ 556 audits
Feed intake (behavior)

**Heat stress**
1. Sudden drop in feed intake
2. Changing feeding behavior
   - (over) eat during the morning

*Large impact on rumen pH/health!* *(acidosis)*

**Thermo neutral zone**
*Normal feed intake*

**DMI variation**
- 30 %
- 25 %
- 20 %
- 15 %
- 10 %
- 5 %
- 0 %
- 5 %
- 10 %
- 15 %
- 20 %
- 25 %
- 30 %

**Ambient temperature**

Mader – Nebraska university
Changes in rumen microflora

Exposure to heat and high humidity affects the rumen microbiota causing significant shifts of microbial populations (direct impact of the rumen temperature):

- Drastic decrease of fibrolytic *Fibrobacter* genus

![Bar chart showing Fibrobacter population at different ambient temperatures.](chart.png)

- Increase of the relative populations of the *Clostridium coccoides-Eubacterium rectale* group of the genus *Streptococcus* (involved in acidosis occurrence)

- As a result, fiber degradation and feed efficiency could be affected and the risk for SARA is increased

*(Tajima et al., 2007; Uyeno et al., 2010)*
How to assess heat stress

- Rumination activity
  Risk Level: <60% of cows lying which are ruminating

- Respiration, panting, foam, drewling

- Feed intake/Rumen fill

- Manure consistency

- Locomotion score
  Risk Level: <90% of cows with a good locomotion score

- Milk fat: protein
  Risk Level: <1.2

- Somatic cell count
  Risk Level: <250,000 cells/ml

- Milk fat: protein

Lallemand internal database shows that 40-60% of farms is in the challenging zone during summer period.
Heat stress abatement and feeding strategies

- Cooling
- Feed/diet quality
- Additives
Nutritional management

- Provide clean and sufficient drinking water
- Feeding fresh and palatable feed
  - Feed more often
  - Use high quality silage
    - Palatable
    - Easily digestible
- Do not change the ration dramatically
- Increase the energy content (increase concentrate)
  - Make sure there is still enough fiber
  - Adjust the protein content
  - Minerals
- Use additives to support rumen health and antioxidant status
Silage quality

Feeding spoiled silages (includes molds / mycotoxins) in rations can have a negative effect on rumen fermentation efficiency

<table>
<thead>
<tr>
<th>Table 2. Effect of the Level of Spoiled Silage on Nutrient Digestibilities for Steers Fed the Four Whole-Plant Corn Rations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>DM intake, lb/day</td>
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<tr>
<td>DM intake, % of body weight</td>
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<tr>
<td>Digestibility, %</td>
</tr>
<tr>
<td>DM</td>
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<tr>
<td>OM</td>
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<tr>
<td>Starch</td>
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<td>CP</td>
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<tr>
<td>NDF</td>
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<tr>
<td>ADF</td>
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</tbody>
</table>

\(^{a,b,c}\) Means within a row with no common superscript differ (P<.05).
\(^{x,y}\) Means within a row with no common superscript differ (P<.10).
Silage quality

Harvest management is a priority!
✓ Chop at proper moisture and length
✓ Pack quickly
✓ Pack tightly
✓ Seal quickly
✓ Use plastic and weights
✓ Manage the feed-out rate upon opening
✓ Properly manage the pile face upon opening

Silages additives can help
Heterofermentative bacteria such as the *L. buchneri* NCIMB 40788 and *L. hilgardii* CNCM I-4785, which produces antifungal compounds that improves stability at feed-out.
Feeding additives: Live yeast and rumen health

Live yeast (Levucell SC) will improve rumen functioning

- Lactate-producing bacteria
- Lactate-utilizing bacteria
- Anaerobic condition (thanks to oxygen scavenging)
- Rumen pH
- Fiber degradation

Levucell® SC
Rumen Specific Yeast

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Levucell SC and rumen pH

Levucell SC reduces the risk of SARA and improves the fiber digestibility

![Graph showing the impact of Levucell SC on rumen pH across different studies and diets. The graph includes data for Spain, USA, France, and Brazil, with variations in rumen pH under control and Levucell SC treatments.](image-url)
**Benefits during heat stress**

**LEVUCELL SC** combined with sodium bicarbonate improves milk yield and rumen efficiency during heat stress

- **Ration**: Corn silage (25.7%) on a dry matter basis, alfalfa hay (16%), concentrate (58.3%)
- **Temperature-Humidity Index (THI)**: 54 days at THI 81 (severe heat stress)

**Milk Yield (+5.1%) and Feed Efficiency (+8.5%)**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LEVUCELL SC I 1077</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5% fat-corrected milk (kg/day)</td>
<td>27.31</td>
<td>28.71</td>
</tr>
<tr>
<td>+1.40 kg +5.10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed efficiency (FCM/Kg DMI*)</td>
<td>1.41</td>
<td>1.53</td>
</tr>
<tr>
<td>+120g +8.10%</td>
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</table>

**Rumen pH with positive consequences on practical indicators (manure consistency)**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>LEVUCELL SC I 1077</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumen pH</td>
<td>6.10</td>
<td>6.90</td>
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<tr>
<td>+0.20</td>
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</table>

**Trial**: University of Teheran, IRAN, 2013

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*FCM : 3.5% Fat Corrected Milk)  
**DMI : Dry Matter Intake)
Oxidative stress

- THI 68

Oxidative stress

- Decreased conception rate
- Lower immunity
- SCC in milk
- Mastitis
- Increased maintenance energy

Impact on cow’s health and fertility
Somatic cell count during the summer

Sources: Suisselab AG Zollikofen, TSM Fiduciaire Sàrl Berne
Antioxidants

Primary antioxidants = prevention
Secondary antioxidants = repair

ROS ($O_2^-$, $H_2O_2$, $OH^-$): physiologically produced by the mitochondria during cell respiration process and by immune cells (activated phagocytes) in the fight against pathogens.

membrane lipids, proteins, DNA alteration

polyphenols, vitamins...
Benefit of antioxidants on milk quality

TAS (Total Antioxidant Status)

% of cows with a positive bacteriology

Switzerland, commercial farm, 2015
Conclusions

- Heat stress is very costly to dairy farmers
  - Do not underestimate the impact
  - Risk of impaired rumen functioning and health
  - Short-term and long-term impact

- Managing the risk:
  - Monitor the risk of heat stress and assess cow’s rumen health (Lallemand Forward Services and on farm-tools)
  - Implement heat abatement strategies and feeding strategies
  - Feed quality silage, take control with inoculants (Magniva)
  - Use feed additives such as live yeast (Levucell SC) and extra antioxidants (Alkosel and Melofeed) to support the rumen
Thank you for your attention
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