The effects of heat stress in late gestation dry cows and the subsequent lactation

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The negative effects of heat stress on lactating cows have long been recognised. Many of the barns housing milking cows have installed fans, some have soaker systems, automatic curtains, all in an effort to reduce heat stress on these cows and mitigate the reduction in feed intake and milk production.

Dry cows have received more attention in recent years but one area that has been neglected is the effect of heat stress on dry cows and the consequences of not providing cooling or effective heat abatement during the hot summer months. Quite the contrary, we often see the dry cows out on pasture, often without access to shade.

There have been several studies published recently looking at the effects of heat stress on dry cows. Tao and Dahl reviewed 114 published papers and references and summarized these into a comprehensive review article in the Journal Dairy Science in 2013. Some of important findings are summarized here.

There is a carryover effect of heat stress on dry cows into the subsequent lactation and cows consistently produced less milk. Several studies demonstrated this difference regardless of herd production level. In the studies shown here (left) herds from 25 kg to about 40 kg average milk production consistently produced more milk if the cows were cooled during the dry period compared to cows not cooled (white bars = heat stressed during the dry period; black bars = cooled during the dry period).

If cooling and heat abatement are only modest then even though milk production is higher, the difference is not significant. If cooling is more extensive then the subsequent difference in milk production, between dry cows that were cooled and those that were not, is significant.

There is a lag between the ambient temperature and the subsequent drop in milk production demonstrating a link to the effects of heat stress on dry cows. The highest ambient temperature did not coincide with the lowest milk production in herds monitored in Florida over 4 years. do Amaral et al. (2009) found that cows that were adequately cooled during the dry period averaged 7.5 kg/day (P=0.01) more milk compared to the heat stressed dry cows and consistently produced more 3.5% fat corrected milk through 210 days in milk (30 weeks) (Figure left: Solid squares – Cooled dry cows; open circles – Heat stressed dry cows). All cows were cooled after calving.
Tao et al. (2011) found that cows that were adequately cooled during the dry period averaged 5 kg/day (P<0.03) more milk compared to the heat stressed dry cows and consistently produced more milk through 280 days in milk (40 weeks) (Figure left: Solid squares – Cooled dry cows; open circles – Heat stressed dry cows). All cows were cooled after calving.

Tao et al. (2012) found that cows that were adequately cooled during the dry period averaged 6.3 kg/day (P<0.01) more milk compared to the heat stressed dry cows and consistently produced more milk through 294 days in milk (42 weeks) (Figure right: Solid squares – Cooled dry cows; open circles – Heat stressed dry cows). All cows were cooled after calving.

All three studies show that cooling cows in lactation did not reverse the negative carry over effects on milk production in those cows that were heat stressed during the dry period.

Two signs of heat stress in cows are increased respiration rate and increased rectal temperature. Studies found that heat stressed dry cows had significantly higher rectal temperatures, both morning and afternoon compared to dry cows that were cooled (Tao et al., 2011) and there is a significant correlation between afternoon rectal temperature in late gestation cows and milk production in the following lactation. (Figure left).

Similar to lactating cows, dry matter intake is reduced in heat stressed dry cows. Tao et al. (2011) used Calan gates from dry off through to 42 days in milk to measure individual cow intakes. Heat stress during the dry period significantly reduced dry matter intake (P<0.02) compared to cows that were cooled. There was not a significant difference in dry matter intake after calving. However, there was a trend (P<0.08) to higher feed intake as cows progressed in lactation to 42 days in milk and produced more milk. (Figure above left: Solid squares – Cooled dry cows; open circles – Heat stressed dry cows). All cows were received cooling after calving.

In a follow up study Tao et al. (2012) again used Calan gates from dry off through to 42 days in milk to measure individual cow intakes. Heat stress during the dry period reduced dry matter intake compared to cows that were cooled. There was a trend to higher feed intake as cows progressed in lactation to 42 days in milk and produced more milk. (Figure above: Solid squares – Cooled dry cows; open circles – Heat stressed dry cows). All cows were received cooling after calving.
Thermal stress during the dry period has an effect on animal health and immune function during the transition period. Both the innate immune function and the adaptive immune function are affected by late gestation heat stress in cows.

In a large study involving 2,600 calving events researchers found a higher incidence of mastitis, respiratory disease and retained placenta in the first 60 days in milk in cows that were dried off in the hot months (June, July, August) compared to cows dried off in the cooler months (December, January, February). Cows dried off in the hot months were bred more often, had longer days to first breeding, and days to pregnancy check in the subsequent lactation compared to the cows dried off in the cooler months. However, there was considerable variation in the responses to heat stressed dry cows in the studies reviewed.

Studies found increased mammary epithelial cell proliferation in those cows that were cooled compared to the cows that were heat stressed during the dry period. The increased mammary growth observed, occurs 3 to 6 weeks prior to calving. This difference in epithelial cell proliferation and mammary growth is linked to the difference in milk production post calving.

It has been postulated that the reduced placental development in heat stressed late gestation cows was directly related to the impaired mammary development and epithelial cell proliferation because there is a linear relationship between calf birth weight and milk yield. Not all studies demonstrated this effect and more studies are needed to elucidate the differences in the mechanisms of placental and mammary development between the heat-stressed and cooled dry cows.

Heat stress in late gestation reduces both mammary and placental blood flow and this in turn limits their development. Heat stressed cows have a lower number of functional secretory cells in the mammary gland and a lower number of cells in the placenta. There appears to be an association between mammary and placental development in late gestation.

Heat stress during the dry period was associated with decreased placental weight. This led to lower circulating placental hormones. A decrease in total uterine and umbilical blood flow and compromised placental vascularization were observed in heat stressed dry cows. As a consequence of reduced placental development, fetal development is compromised and calf birth weights are lower.

<table>
<thead>
<tr>
<th>Dry cow treatment</th>
<th>Heat stress</th>
<th>Cooled</th>
<th>Difference</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Birth weight (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36.6</td>
<td>39.7</td>
<td>3.1</td>
<td>0.05</td>
<td>Collier et al., 1982</td>
</tr>
<tr>
<td>40.6</td>
<td>43.2</td>
<td>2.6</td>
<td>0.05</td>
<td>Wolfenson et al., 1988</td>
</tr>
<tr>
<td>33.7</td>
<td>37.9</td>
<td>4.2</td>
<td>0.10</td>
<td>Avendano-Reyes et al., 2006</td>
</tr>
<tr>
<td>40.8</td>
<td>43.6</td>
<td>2.8</td>
<td>0.05</td>
<td>Adin et al., 2009</td>
</tr>
<tr>
<td>31.0</td>
<td>44.0</td>
<td>13.0</td>
<td>0.001</td>
<td>do Amaral et al., 2009</td>
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<tr>
<td>39.5</td>
<td>44.5</td>
<td>5.0</td>
<td>0.05</td>
<td>do Amaral et al., 2011</td>
</tr>
<tr>
<td>41.6</td>
<td>46.5</td>
<td>4.9</td>
<td>0.01</td>
<td>Tao et al., 2011</td>
</tr>
<tr>
<td>36.5</td>
<td>42.5</td>
<td>6.0</td>
<td>0.01</td>
<td>Tao et al., 2012</td>
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Several studies also revealed that **heat stressed dry cows had, on average, shorter gestation periods** by as much as 7 days compared to cows that were cooled. This may be part of the reason that these cows have lower milk production – they had a shorter time dry for mammary development. As much as 60% of fetal growth takes place in the last 2 months of gestation so a reduction in gestation length accounts for some of the reduction in birth weight in calves from heat stressed dry cows. The decreased feed intake observed may also contribute to the lower birth weight. However, a modest reduction in energy intake did not have an effect on calf birth weight.

The effects of heat stress on dry cows are profound. **There are significant carry over effects into lactation with substantial economic implications. The deleterious effects of heat stress in the dry period cannot be corrected by improving the environment (cooling) for cows once they start milking.** By any measure, the production and physiological effects on cows and the effects on the calf from heat stress on dry cows are significant contributors to lower overall productivity and profitability.

**References:**


