# Methionine's role in heat stress: more than just milk protein and fat

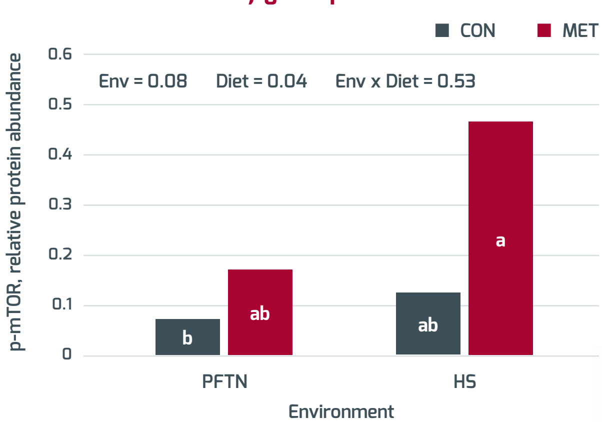
**Each year we see a drop in milk yields, protein, and fat during the hot summer months, causing significant economic losses for our dairy farms. One way to help overcome these drops in production is to focus on meeting essential nutrient requirements. Research over the last few years has highlighted the role of functional amino acids, such as methionine, to mitigate the negative effects of heat stress (HS).**

In a previous SmartMail we presented data from Pate et al., (2020), who investigated the effect of HS on lactation performance when cows were fed supplemental methionine was provided as Smartamine® M (MET) or without (control; CON). In that SmartMail we highlighted that while HS had a significant negative effect on milk protein and fat content, cows supplemented with MET had less of a decrease in milk protein during HS and had greater milk fat than CON cows during HS.

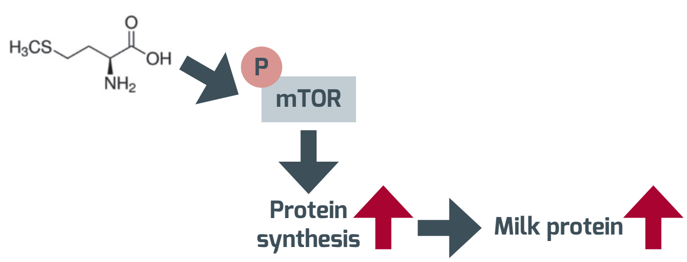
However, more and more research has revealed that HS also has negative impacts on dairy cow metabolism, immune responses, and oxidative stress. As part of this research, studies have revealed that the benefits of methionine during HS extend beyond just milk production.

Following cows from the study by Pate et al. (2020), Coleman et al. (2022a) observed an increase in the abundance of phosphorylated mTOR (active mTOR) in mammary tissue with MET during both HS and thermoneutral (TN) conditions. As a regulator of protein synthesis, this increase in mTOR activation provides a link to the better milk protein response of MET cows during HS. Additionally, since mTOR activation occurred during both HS and TN conditions, it points to the important role of methionine in setting up the cow to better handle the negative effects of HS on milk protein.

**Mammary gland p-mTOR abundance**

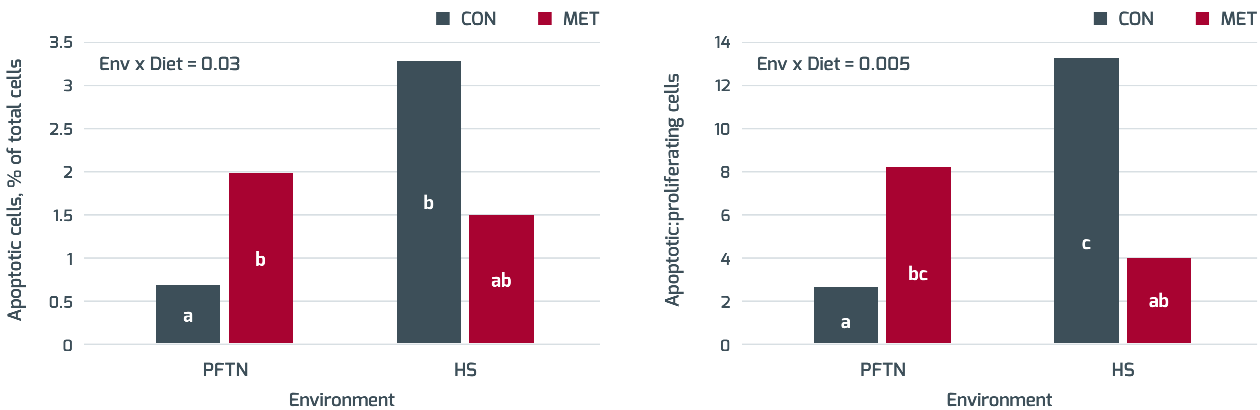



**mTOR activation by methionine**



Also in the mammary gland, Pate et al. (2021) observed an increase in the percentage of apoptotic (dying cells) and in the ratio of apoptotic to proliferating cells (cells dying to cells growing) in CON cows during HS. However, this increase was not observed when methionine was supplemented during HS. This points towards better cellular protection capacity in the mammary gland with methionine and is important because less cells dying means more cells can grow and produce milk.

**Mammary histology results**




Coleman et al. (2022b) also explored the effects of methionine in the liver during HS. Similar to the mammary gland, MET cows also had greater phosphorylated mTOR abundance in the liver, again pointing towards better protein synthesis and preparation for the stress of HS. They observed that HS had a negative impact on liver insulin and antioxidant signaling, with changes in the abundance of proteins during HS compared to TN conditions. However, MET maintained the abundance of proteins in those pathways during HS compared to TN conditions, indicating that liver metabolism of those cows was more normally sustained than that of CON cows during HS.

| | | HEAT STRESS CHANGE FROM TN | |
|---|---|---|---|
| **Protein** | **Function** | **CON** | **MET** |
| **Insulin receptor** | Binds insulin to initiate glucose uptake | ⬆ | – |
| **p-AKT** | Kinase activating mTOR and involved in insulin signaling | ⬆ | – |
| **Glucose transporter 4** | Transport of glucose into cell | ⬆ | – |
| **Glutathione peroxidase 1** | Antioxidant enzyme | ⬆ | – |
| **Cullin 3** | Regulator of antioxidant gene expression | ⬆ | – |

Moreover, in whole blood, MET cows had greater mRNA abundance of transsulfuration pathway (pathway of methionine metabolism where antioxidants are produced) and antioxidant genes during TN compared to HS conditions (Coleman et al., 2022b). This suggests that the MET cows did not need to upregulate antioxidant pathways during HS because they already had a better antioxidant status and were thus better prepared to handle HS induced oxidative stress.

Beyond these benefits, research presented at the 2023 ADSA Annual Meeting from the University of Wisconsin-Madison, reported benefit of methionine during transition period HS. In this study they again reported a benefit of methionine on milk protein percentage (0.18% increase with methionine compared to control during HS; Davidson et el., 2023). Looking metabolically, they also observed that supplying methionine to peripartum cows under HS improved liver function (Guadagnin et al., 2023), which can help the cow to better handle the negative metabolic effects associated with HS.

## CONCLUSION

While methionine is an essential nutrient best known for its effects on milk, protein and fat during lactation, data continues to grow on its importance for health and metabolism. Recent research is uncovering the benefits of methionine in preparing cows to handle the negative effects of HS conditions, further underscoring the importance of meeting dairy cow methionine requirements.

## REFERENCES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