Simulation of heat stress in in-vitro rumen fermentation

Rajan Dhakal, Niels Moritz, Christine Brøkner, Andre Luis Alves Neves, Volker Krömker, Svenja Woudstra

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UNIVERSITY OF COPENHAGEN

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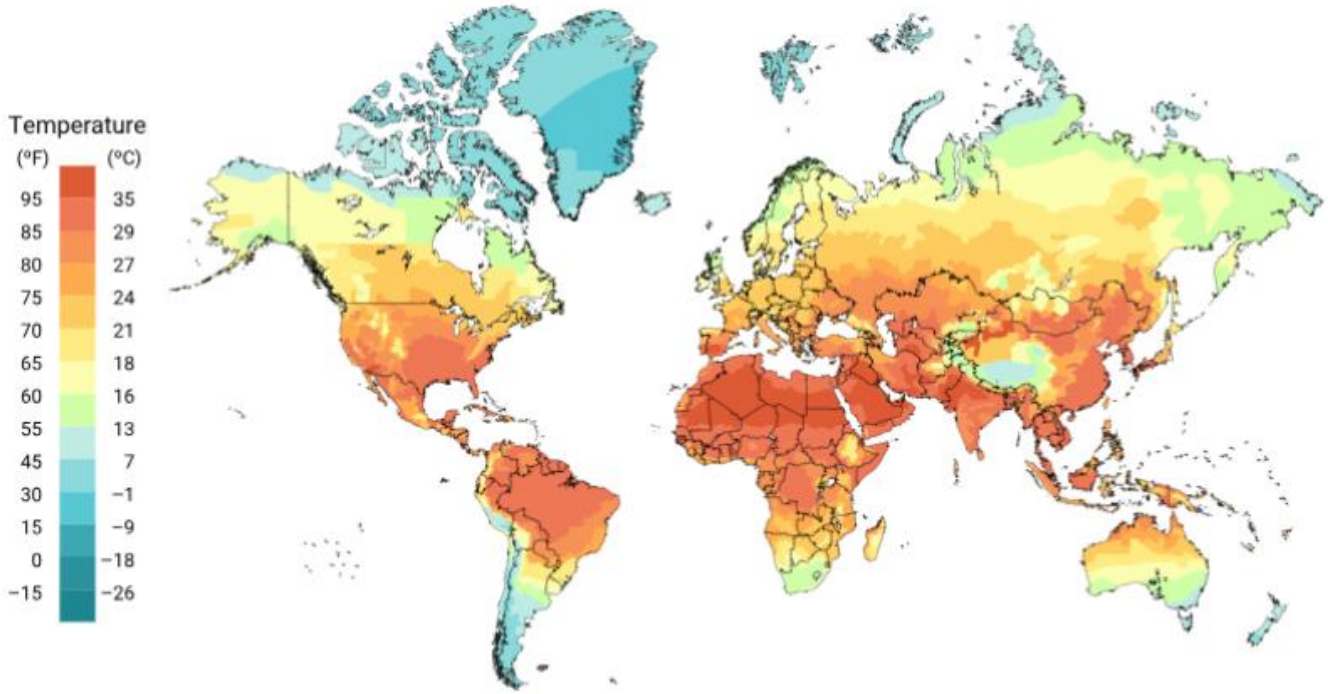
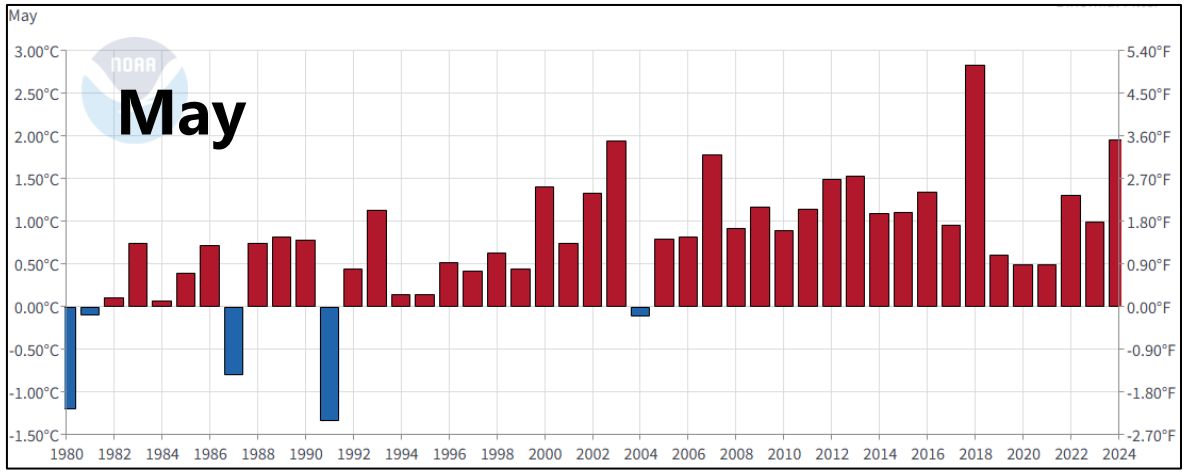
Background

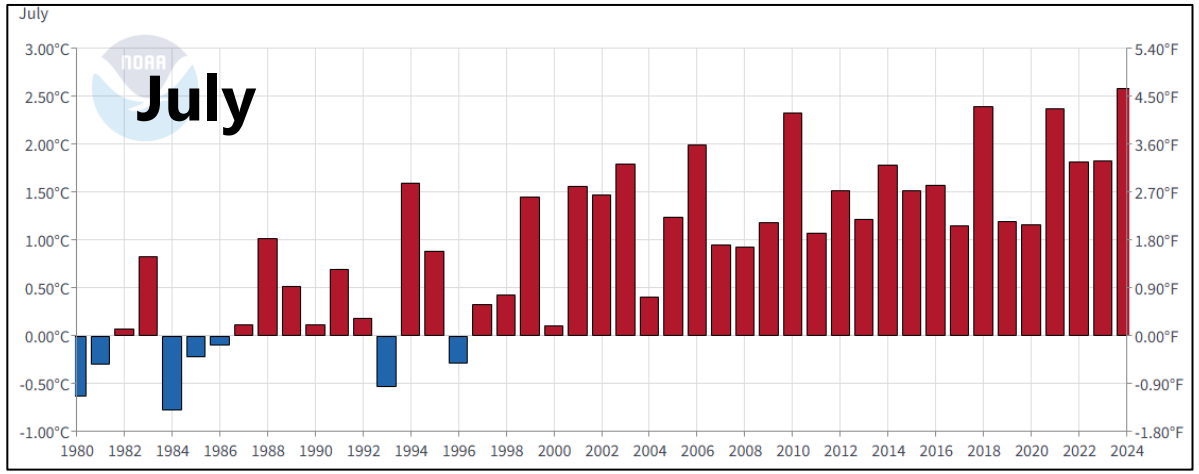
-IPCC has predicted that planet's surface temperature increase by 1.5 °C between 2030 and 2052.

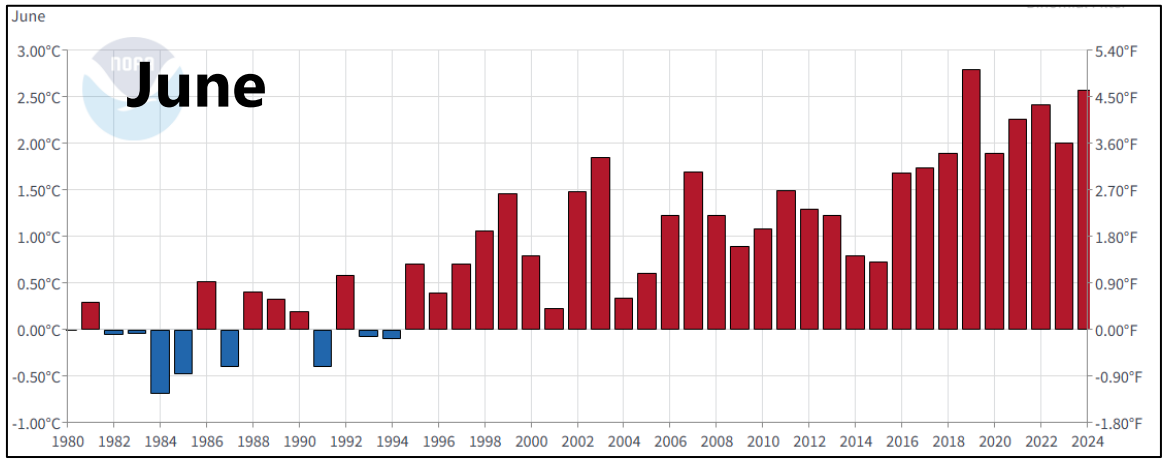
-Global climate change has led to an increased frequency and duration of heat waves across the globe.

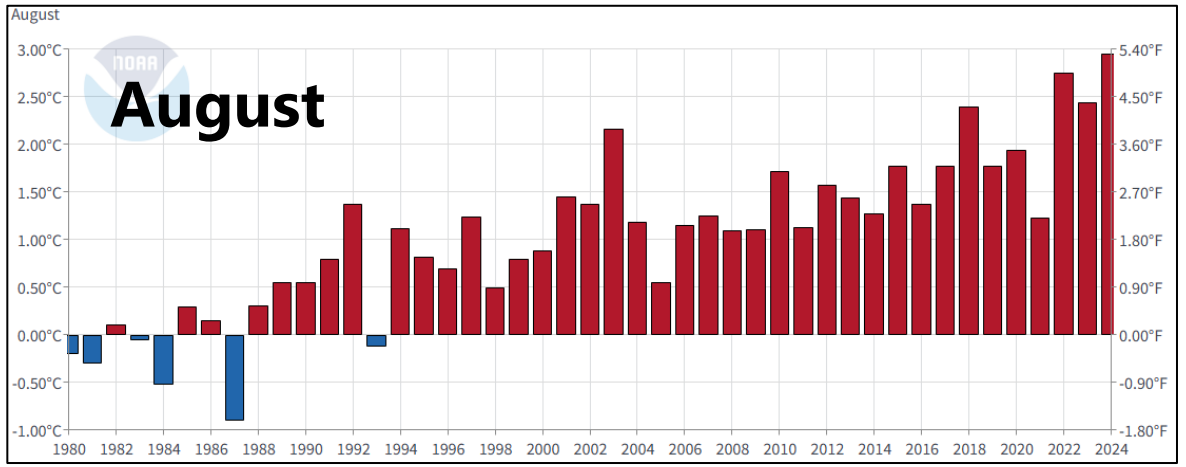


Europe average temperature anomalies in May, June, July and August





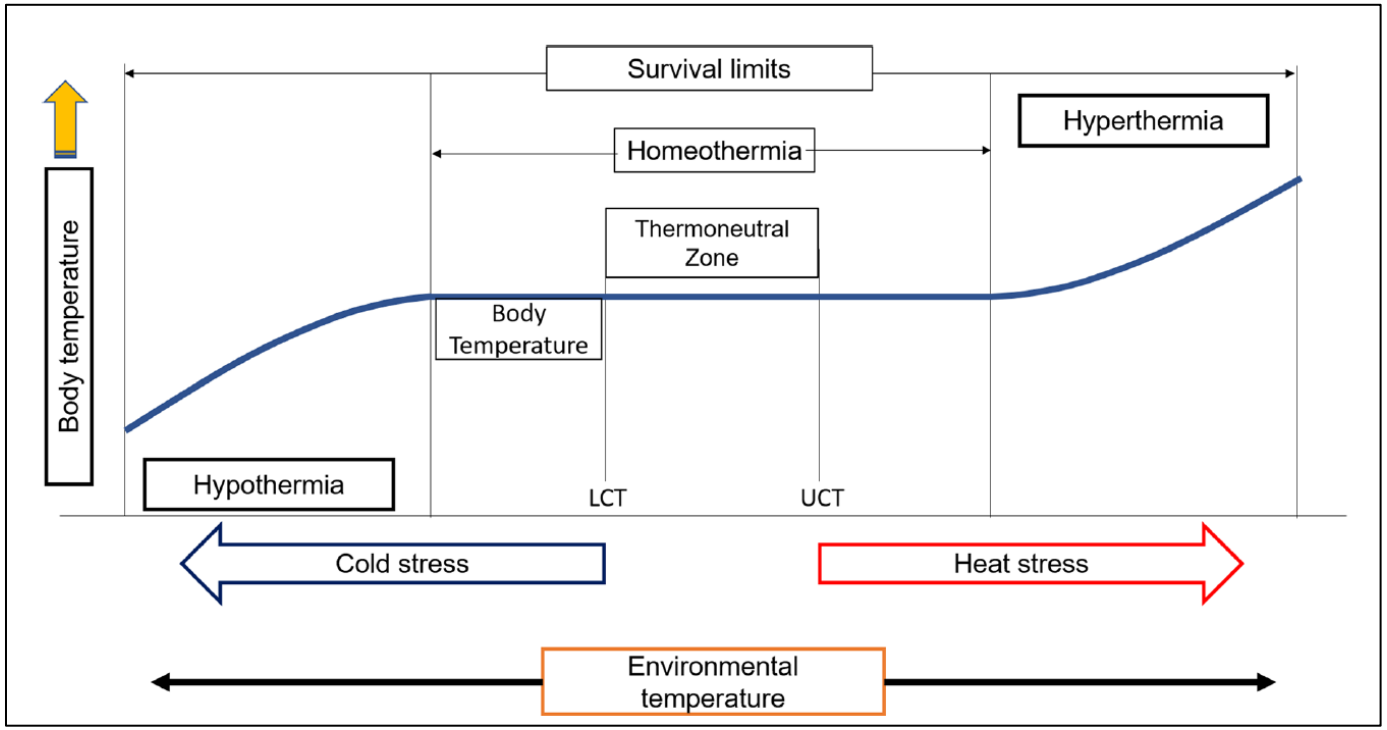




https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series

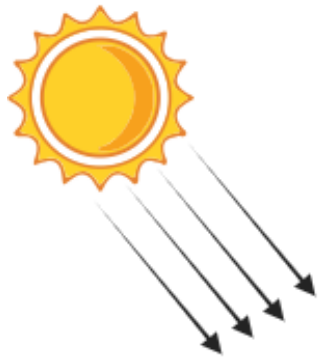
-Heat stress occurs when cows cannot dissipate excess heat due to high environmental temperatures and humidity.

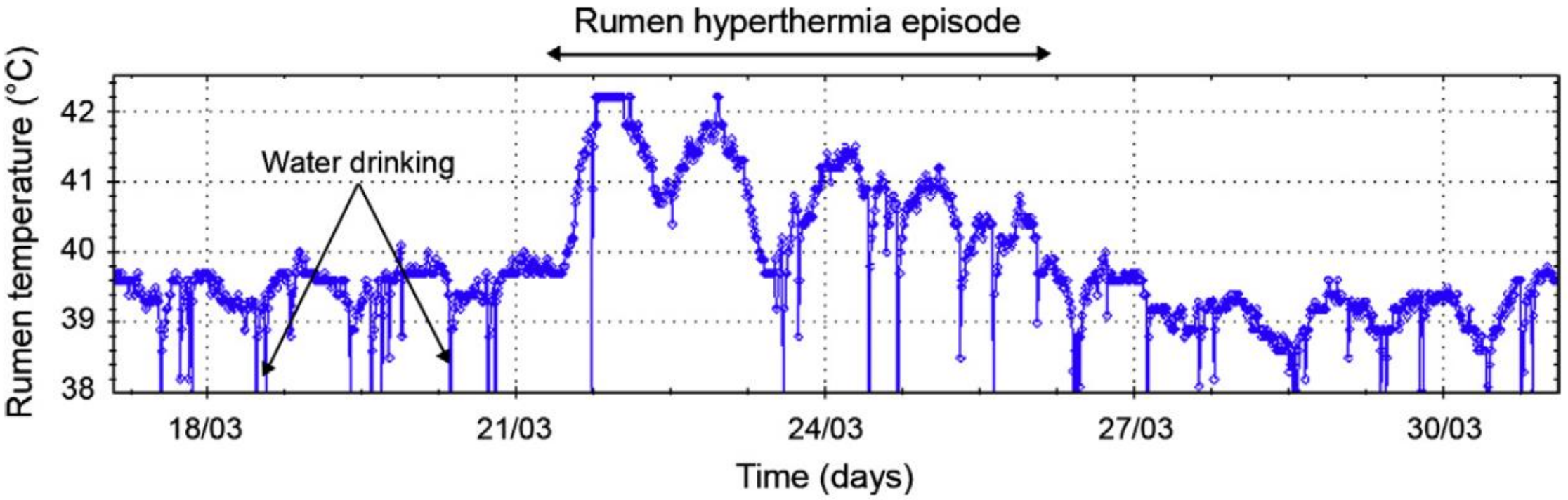
-Dairy cattle are particularly susceptible to heat stress as milk production generates increased metabolic heat load.



Body temperature variation with an increase or decrease in environmental temperature. LCT is the lower critical temperature, and UCT is the upper critical temperature

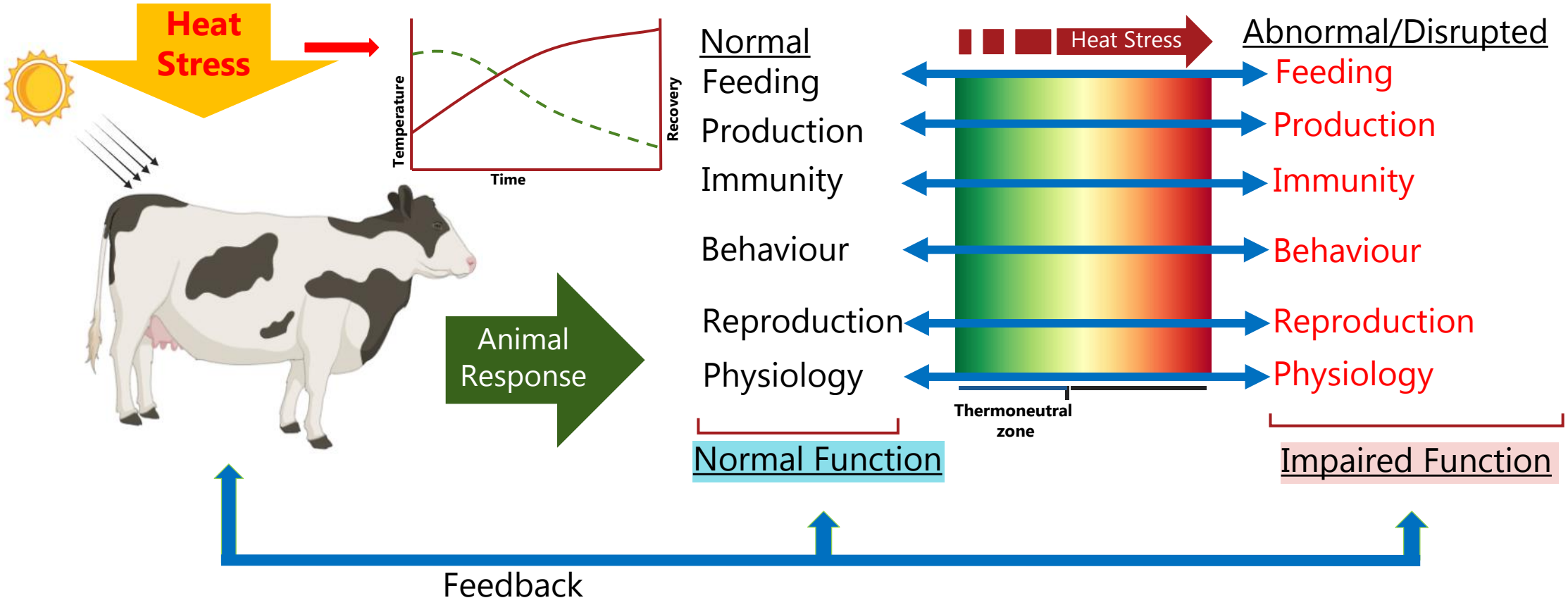
https://doi.org/10.1007/s11356-021-14077-0





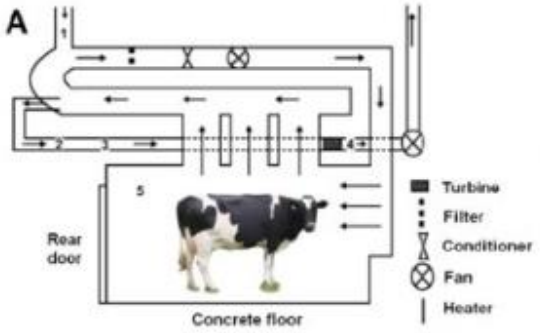
DOI: 10.1016/j.tvjl.2010.09.012

A schematic representation of animal responses to potential heat stress



Experimental methods

In-vivo

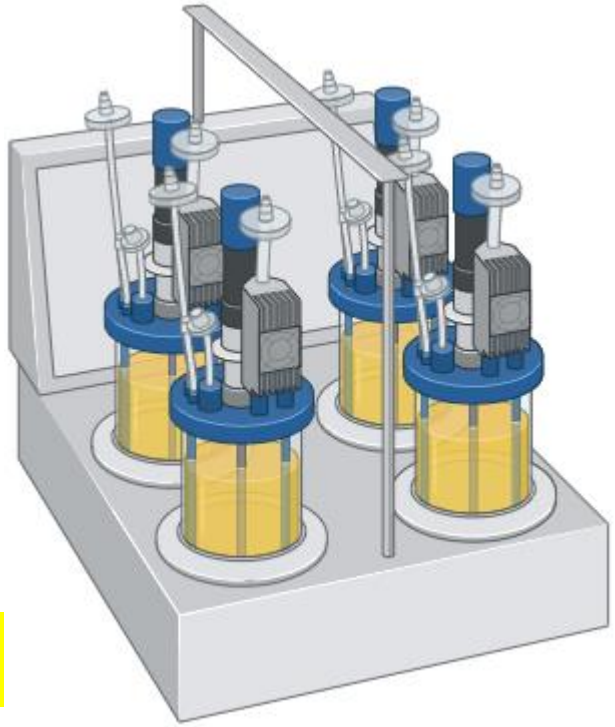


How fast ?

How easy?

Operational cost?

In-vitro



https://www.researchgate.net/publication/321148784_Methane_production_in_dairy_cows_Individual_cow_variability_in_methane_production

Objectives

- Establish in-vitro method to test temperature effect on rumen fermentation (rumen hyperthermia).
- Quantify the effect on in-vitro rumen fermentation products (e.g. SCFA (short-chain fatty acids)) and by-products of rumen fermentation.

Methodology

Rumen sensor data

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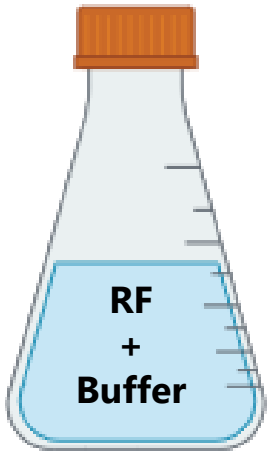
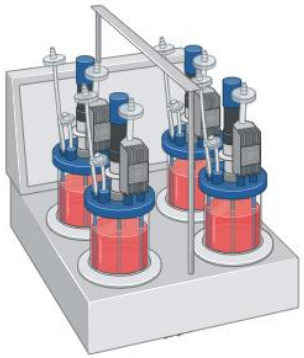
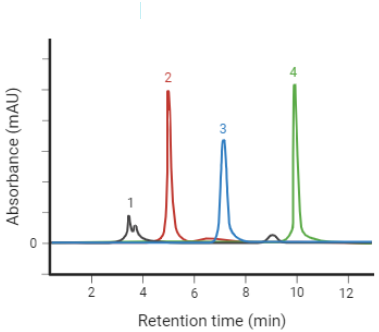
Static in-vitro method





48 hours



Volatile fatty acids

pH, total gas production

Sample Collection

Temperature: 39.5, 40.5, 41.5, 42.5 and 43.5 C

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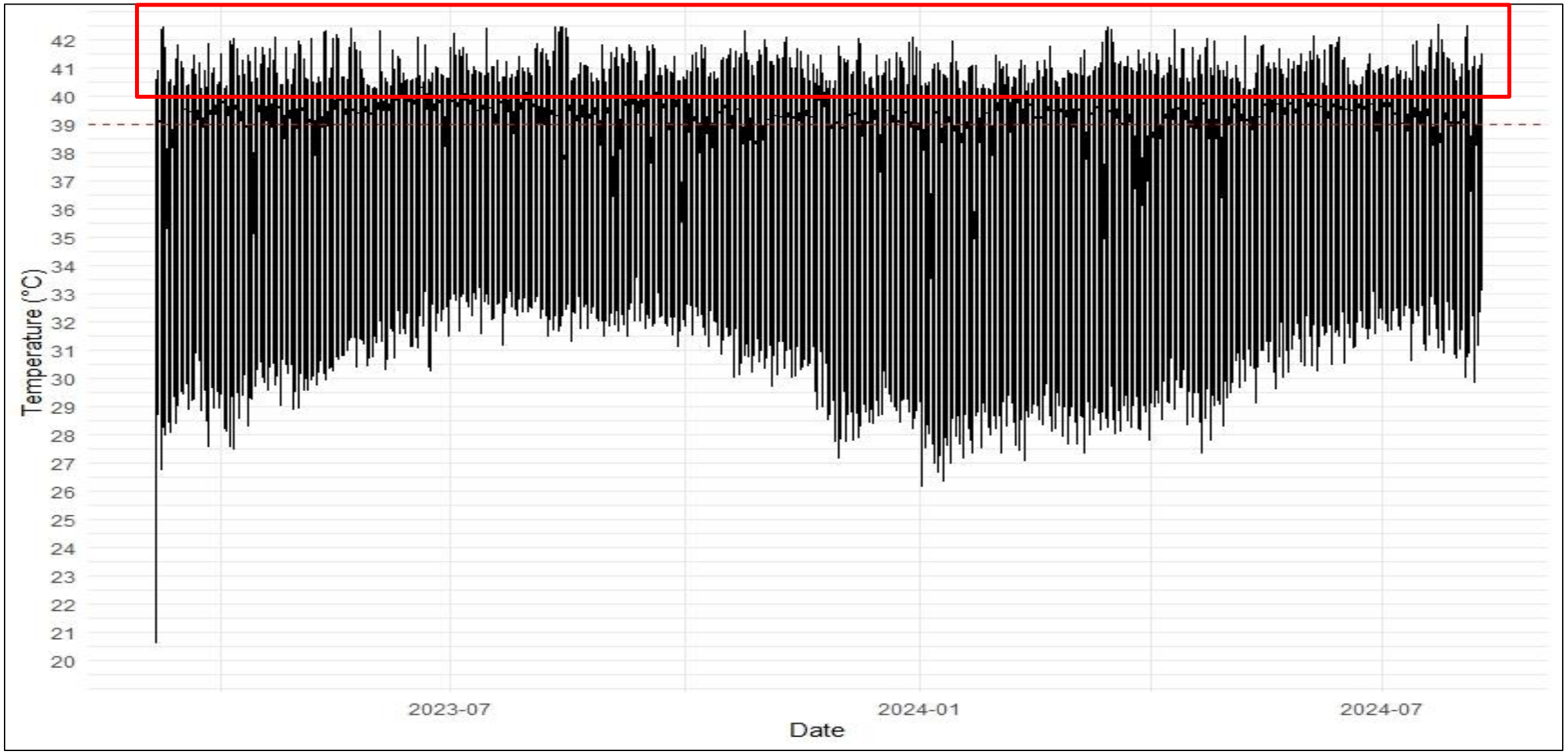
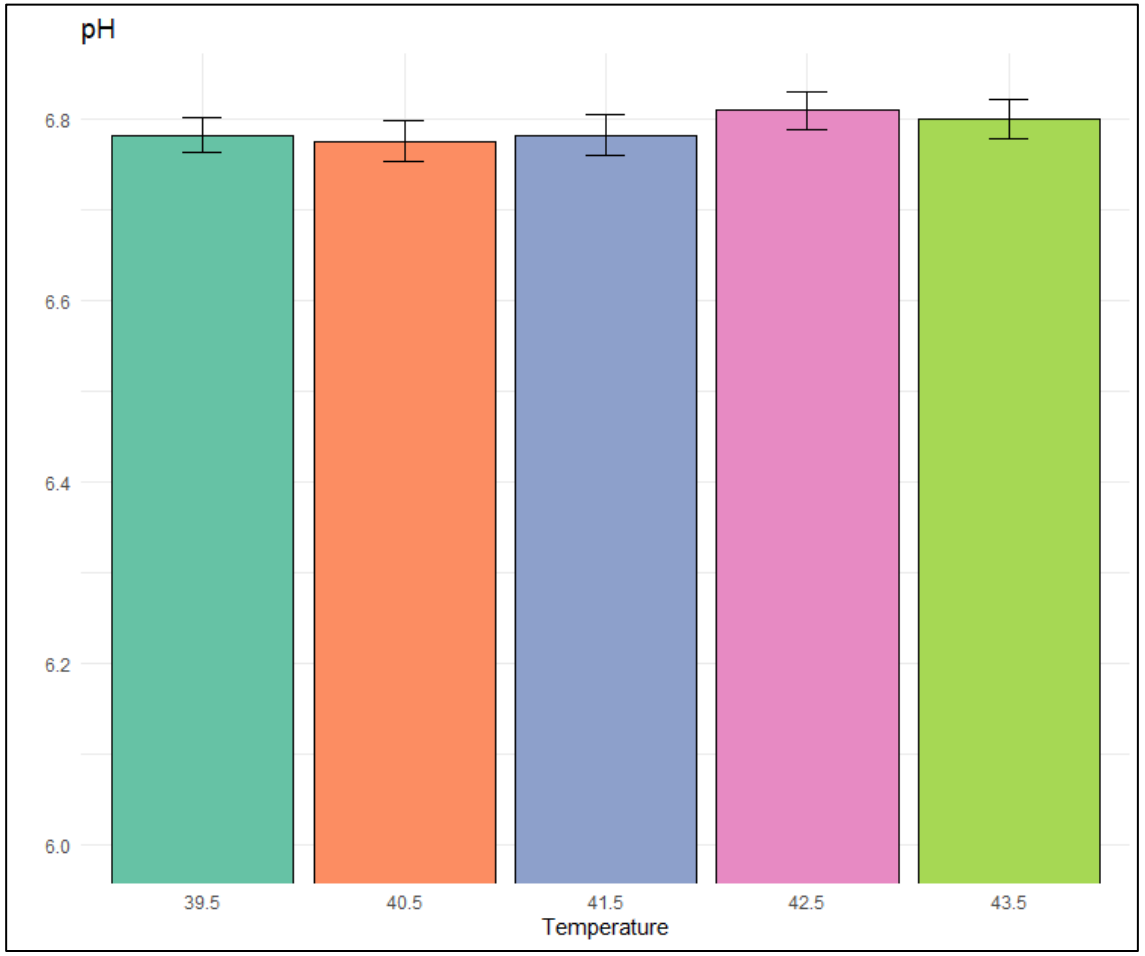
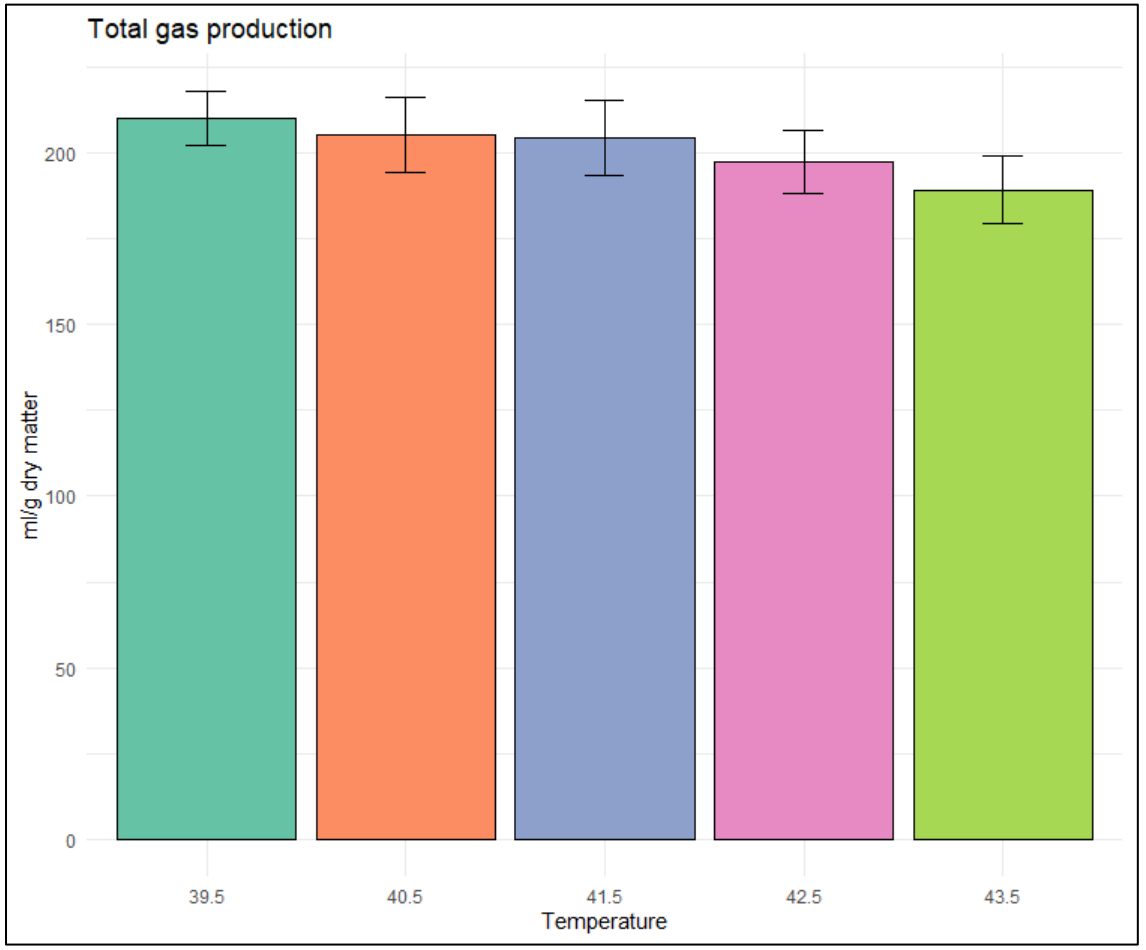
Results

Reticulo-rumen temperature produced from Smaxtex data

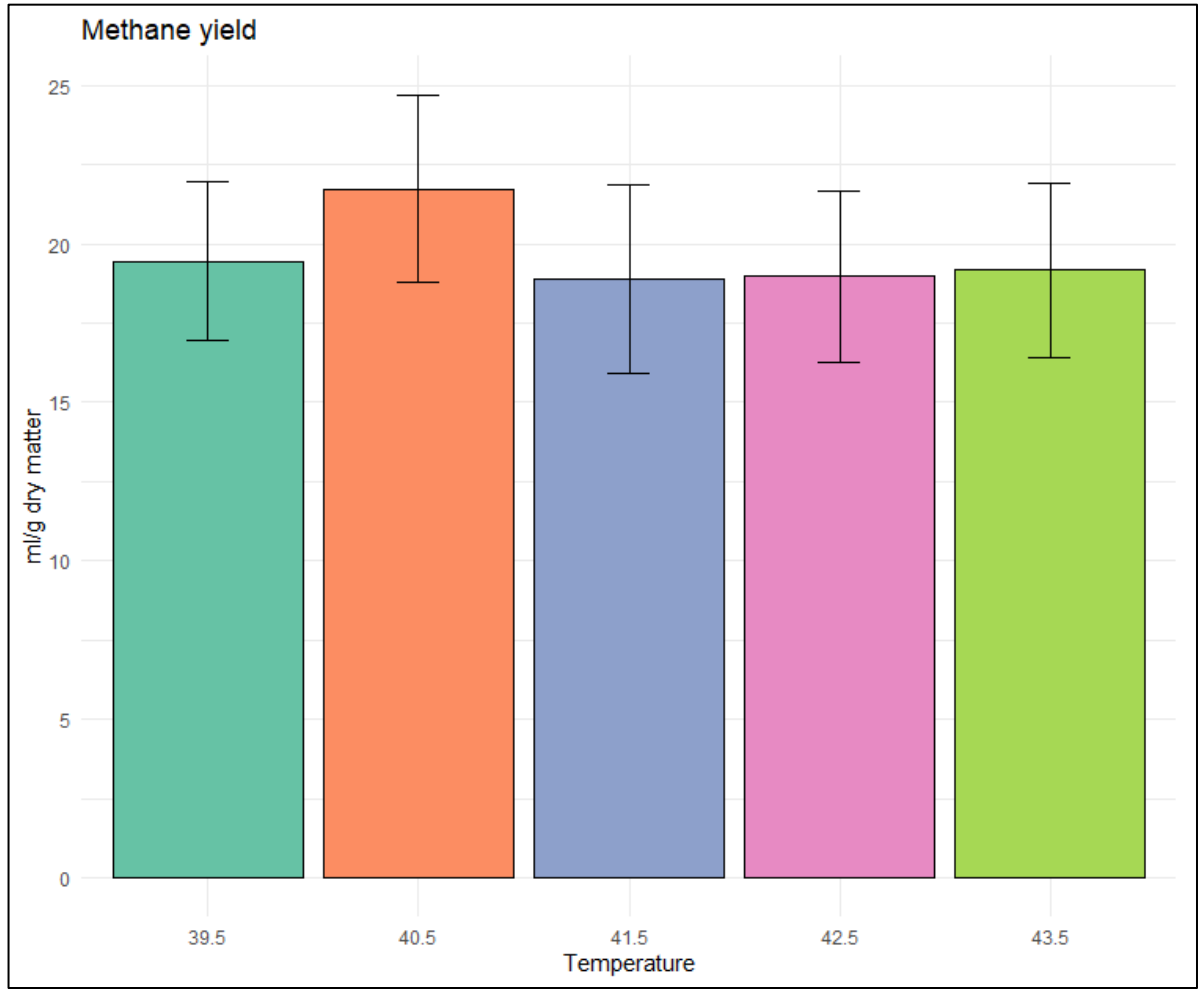


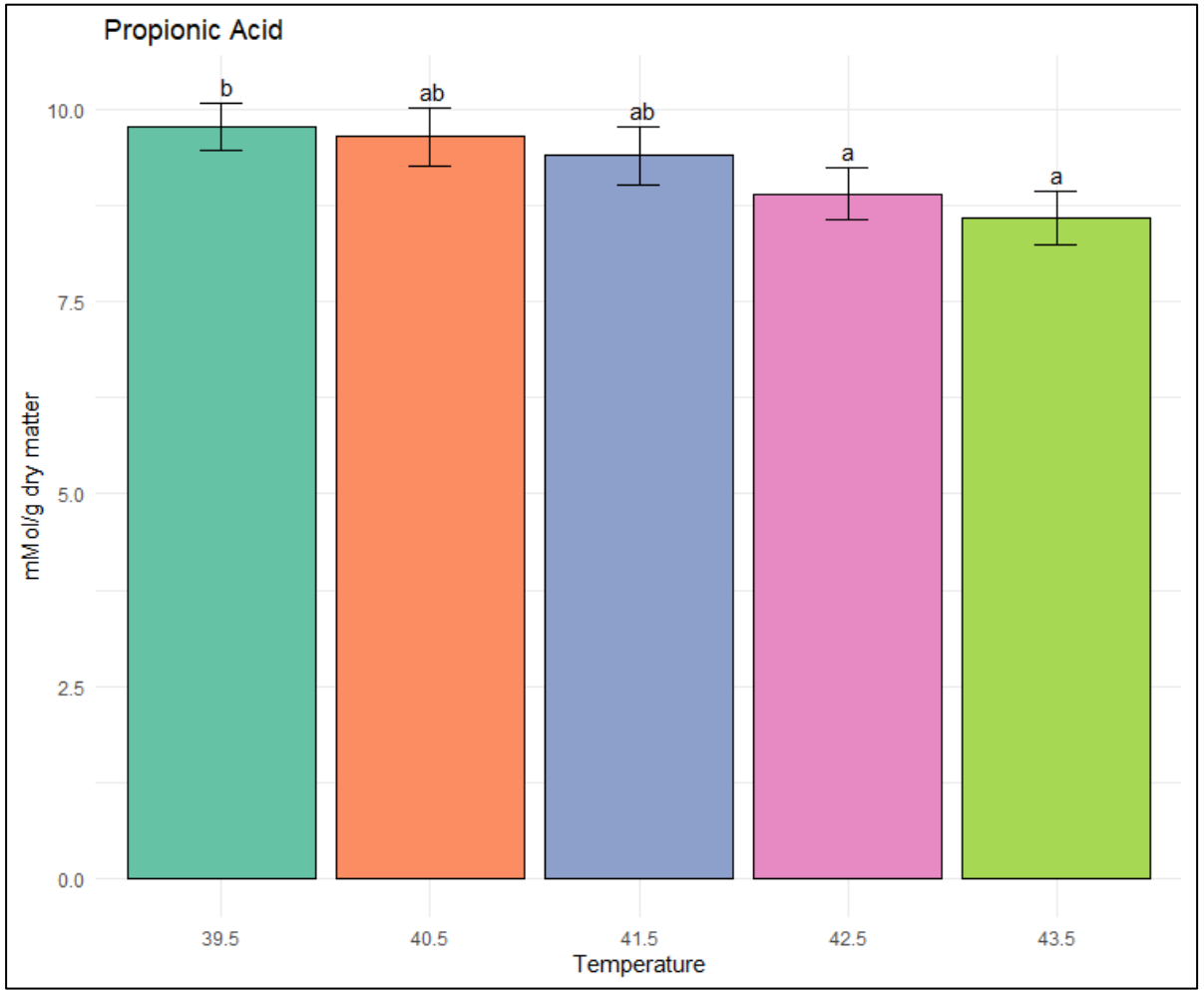
Fermentation parameters





Fermentation parameters





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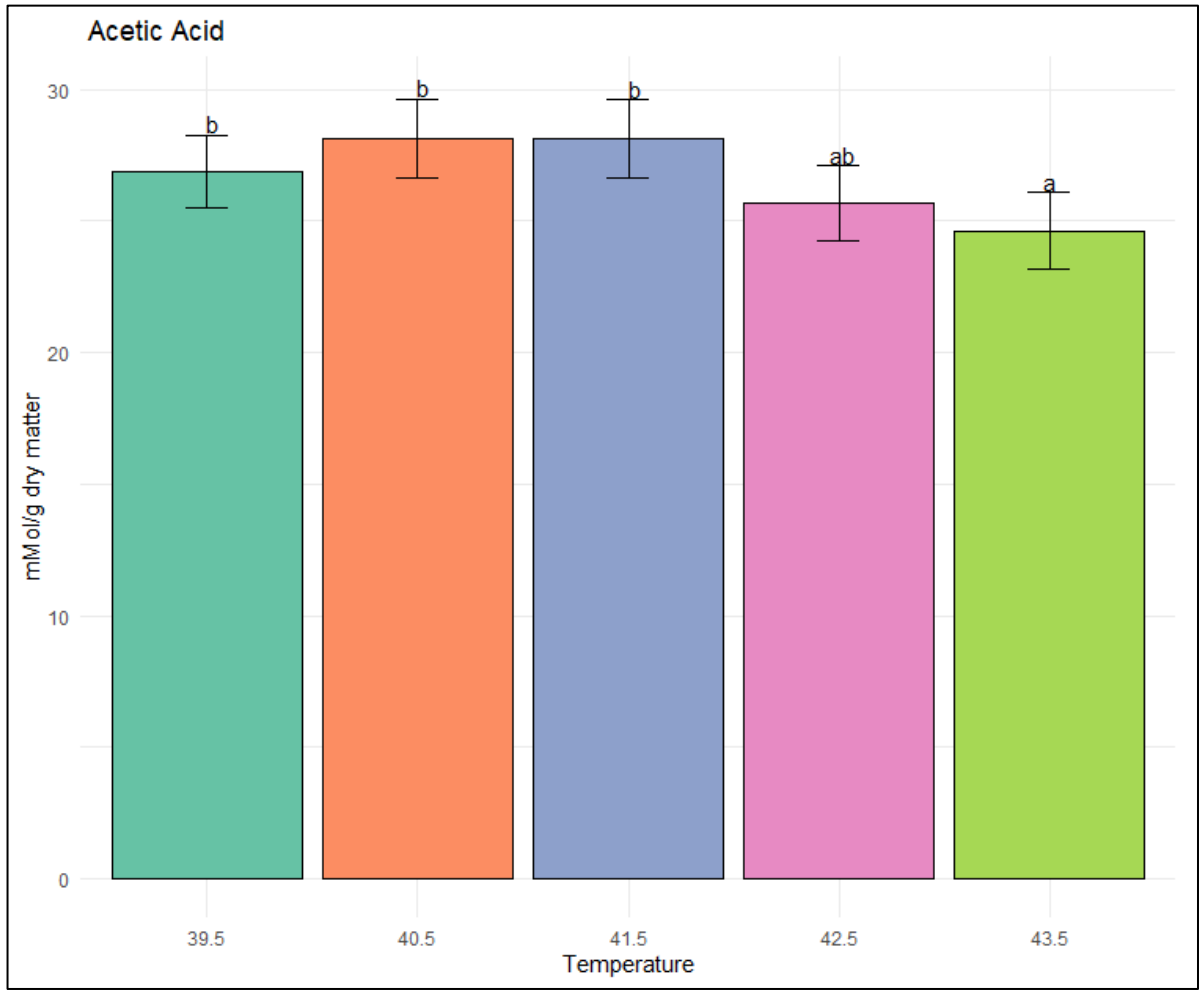

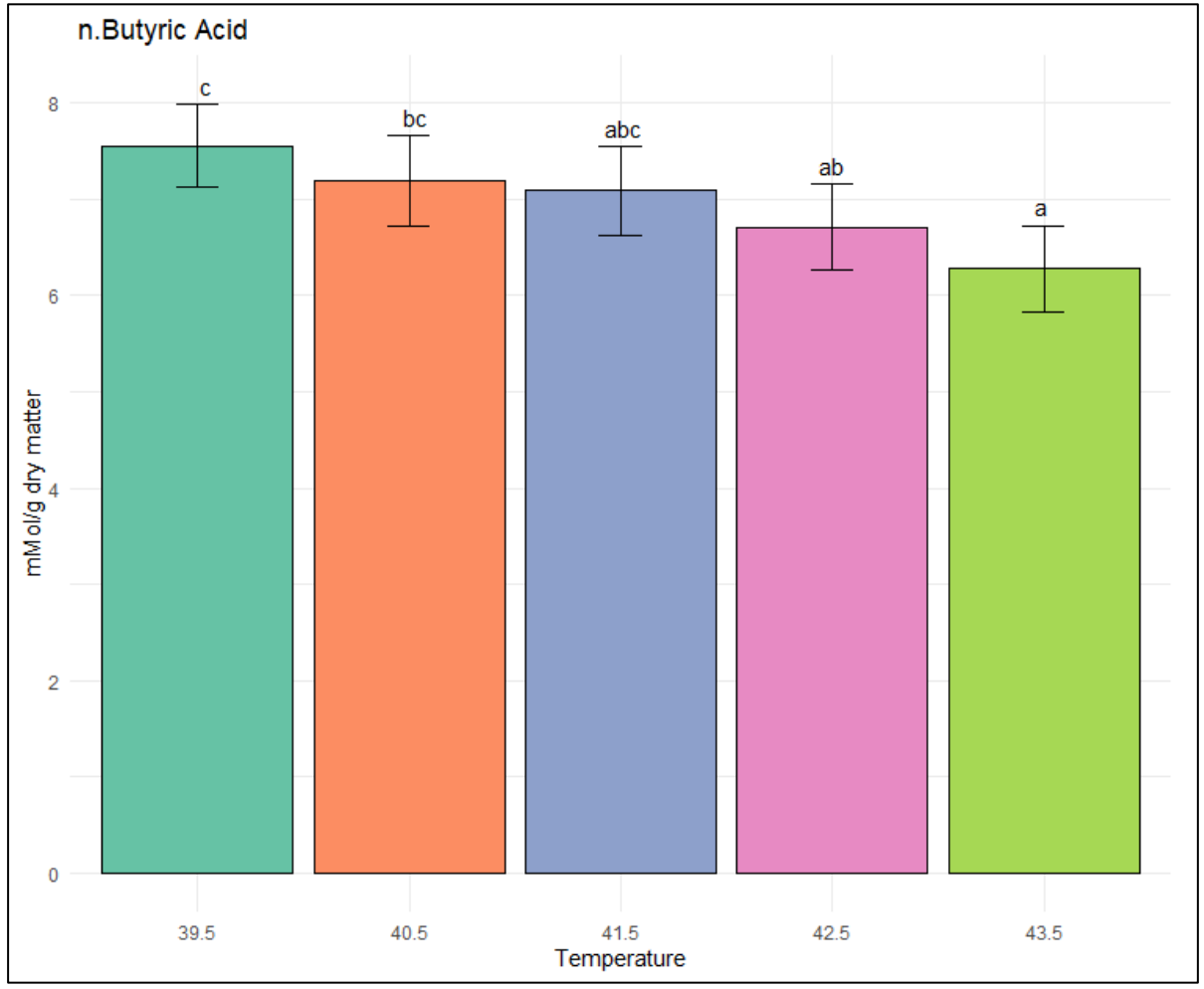

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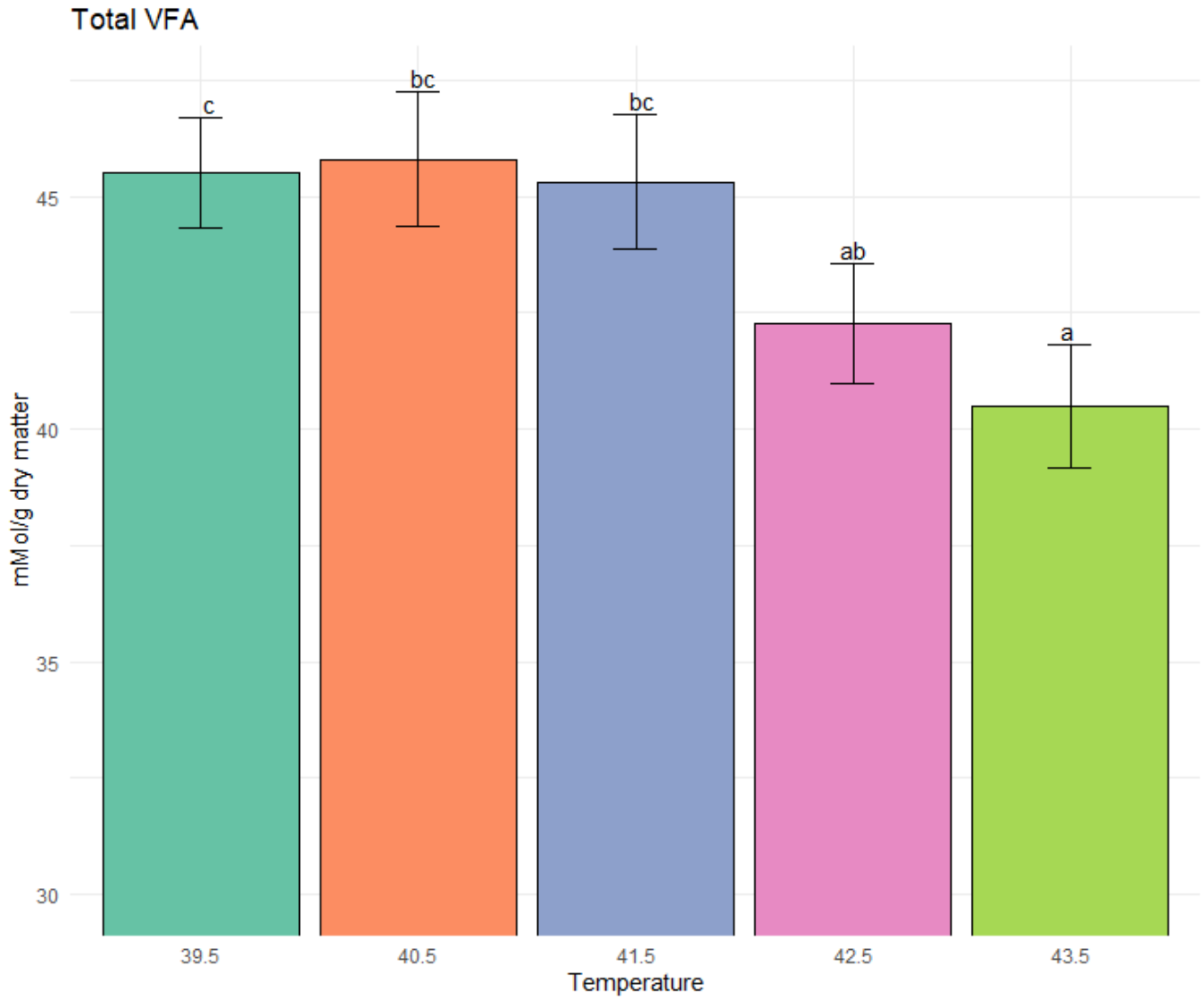

Conclusion

- Yes, we can simulate the heat stress (rumen hyperthermia) in in-vitro.
- The increase in-vitro rumen temperature affects the fermentation kinetics and its parameters.
  - The increased temperature can effect total gas production, total VFA, acetic, propionic, and butyric acids.

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