Effect of live yeast on greenhouse gas emissions and energy partitioning of growing steers in heat-stress conditions

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Introduction

Beef cattle exposed to heat stress during the growing period of feeding are less energetically-efficient than animals exposed to thermoneutral conditions due to an increased energy expenditure in order to regulate body temperature. Additionally, cooling techniques such as panting and increased respiration may increase beef's greenhouse gas (**GHG**) emissions. Live yeast (**LY**) supplementation has been shown to improve digestibility and mediate rumen pH, leading to a more stable and favorable rumen environment (Crossland et al., 2018).

Objective

To evaluate the efficacy of the inclusion of a live yeast supplement to reduce the effects of heat stress such as inefficient energy expenditure and increased greenhouse gas emissions.

Materials and Methods

- Eight Angus-crossbred steers (BW 365 ± 32 kg, 28 mo of age)
- Two **TEMP** conditions on d 13 and 14
  - Thermoneutral (**TN**; 18.4 ± 1.1°C, 57.6 ± 2.8 % RH)
  - Heat stress (**HS**; 33.8 ± 0.6°C, 55.7 ± 2.7 % RH)
- Grower **DIET** fed at 1.2% SBW for 14 d
  - No live yeast supplementation (**NOY**)
  - 10 g live yeast/d top-dressed (1.2 x 10^{12} CFU/d)
- Two side-by-side, single-stall open-circuit, indirect respiration calorimetry chambers
- Statistical analysis: 2 × 2 crossover design using a random coefficients model
  - Homogeneity of variances analyzed using Brown-Forsythe test
  - Significance set at $P \leq 0.05$
  - Tendency set at $P \leq 0.10$
  - Carryover interactions were analyzed and removed from the model if not significant ($P > 0.05$).

Gas Flux Results

Gas flux	TEMP: TN	TEMP: HS	DIET: NOY	DIET: LY	*SEM*	*P*-values: TEMP	*P*-values: DIET	*P*-values: TEMP × DIET
O_2 consumption[1], L/d	1,868.07	1,851.77	1,855.93	1,863.91	70.41	0.500	0.740	**0.007**
CO_2 emission, L/d	1,983.63	1,961.35	1,950.18	1,994.79	91.47	0.584	0.277	0.685
CH_4 emission, L/d	210.21	201.88	204.30	207.79	10.20	0.154	0.543	0.752
CH_4 yield, g/kg DM	30.55	29.18	29.68	30.06	1.43	0.096	0.637	0.613

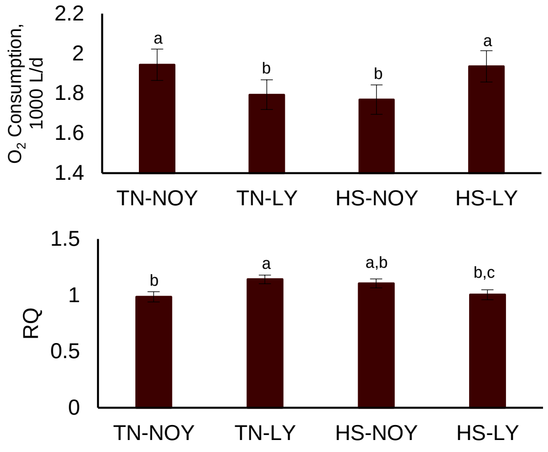
[1]Significant carryover interaction of **DIET** (P = 0.0049).

Energy Partitioning Results

Energy Partition	TEMP: TN	TEMP: HS	DIET: NOY	DIET: LY	*SEM*	*P*-values: TEMP	*P*-values: DIET	*P*-values: TEMP × DIET
RQ[1]	1.06	1.05	1.04	1.07	0.03	0.728	0.262	**0.016**
GEI, Mcal/d	18.4	18.5	18.4	18.5	0.61	0.804	0.439	0.298
FE, Mcal/d	7.16	6.74	7.14	6.76	0.58	0.306	0.342	0.205
DE, Mcal/d	11.3	11.7	11.3	11.7	0.63	0.304	0.316	0.152
UE, Mcal/d	0.25	0.26	0.26	0.25	0.03	0.795	0.438	0.645
GASE, Mcal/d	1.83	1.76	1.78	1.81	0.09	0.154	0.543	0.753
ME, Mcal/d	9.27	9.65	9.25	9.66	0.65	0.377	0.335	0.210
HE, Mcal/d	9.43	9.31	9.32	9.43	0.34	0.372	0.429	0.955
RE, Mcal/d	-0.18	0.36	-0.08	0.26	0.62	0.259	0.247	0.240
NE_{mr}[2]	21.05[a]	26.14[b]	23.56	23.63	0.81	**<0.0001**	0.756	0.744

[a-b]Least square means with superscripts differ at P ≤ 0.05.
[1]Significant carryover interaction of **DIET** (P = 0.0217).
[2]Net energy maintenance requirements (NE_{mr}) calculated using equations from Tedeschi and Fox (2020).

Significant Interactions



Conclusion

- Live yeast supplementation during **HS** increased oxygen consumption, but the opposite reaction occurred during **TN** conditions
- Live yeast supplementation during **HS** did not change greenhouse gas emissions
- Energetic efficiency (RQ) did not change during heat stress with **LY**, but increased RQ during **TN** conditions
- Net energy maintenance requirements were higher during **HS** conditions than **TN** conditions; **DIET** had no effect
- Further research should be completed to understand the relationship between **TEMP**, **DIET**, and oxygen consumption.

Photographs provided by G. M. D'Souza (2019)

Crossland, W. L., A. B. Norris, L. O. Tedeschi, and T. R. Callaway. 2018. J Anim Sci 96(7):2861-2876.
Tedeschi, L. O., and D. Fox. 2020. The Ruminant Nutrition System. 3rd ed.