

Serotonin regulation of maternal calcium, glucose and fatty acid metabolism in dairy cows

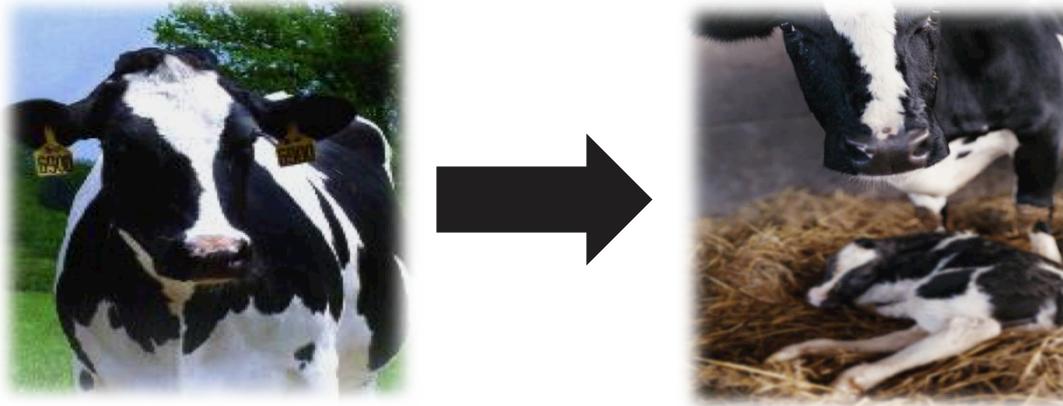
Jimena Laporta

Graduate Research Assistant
Lactation Physiology



DEPARTMENT OF
DAIRY SCIENCE
University of Wisconsin-Madison

Transition period



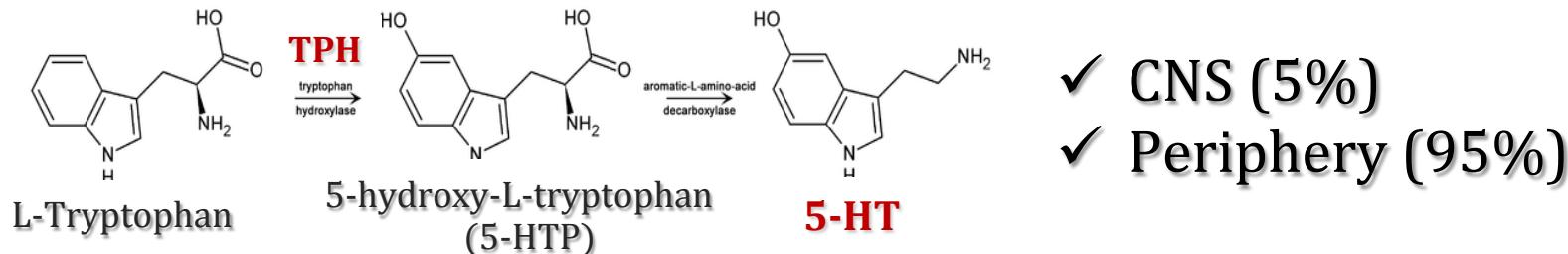
Research focus:

Mammary gland, liver and bone
regulation of calcium and energy homeostasis.

How can we make these processes more efficient?



Serotonin (5-hydroxytryptamine, 5-HT)

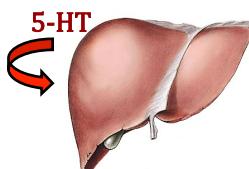


Peripheral 5-HT in the context of lactation



Regulates tight junctions and milk synthesis
Regulates PTHrP expression

(Stull et al., 2007; Collier et al., 2012, Hernandez et al., 2012)



Glucose and fatty acid metabolism
Hepatic regeneration

(Sumara et al., 2013; Lesurtel et al., 2012; Watanabe et al., 2011)



Regulates bone mass

(Modder et al., 2010; Ducy 2010)



Observational study



Is it relevant during lactation?



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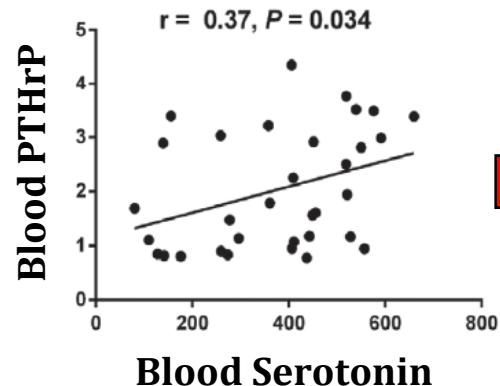
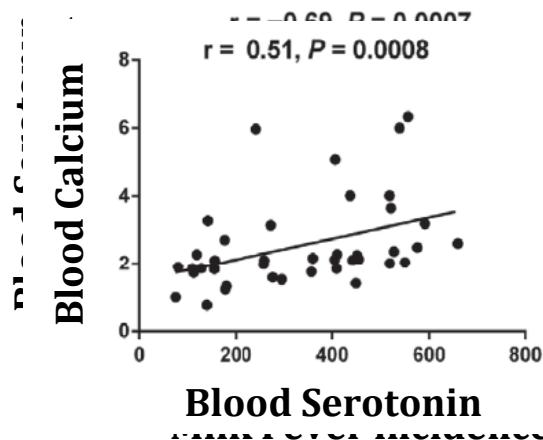
Short communication: Circulating serotonin (5-HT) concentrations on day 1 of lactation as a potential predictor of transition-related disorders

J. Laporta, S. A. E. Moore, M. W. Peters, T. L. Peters, and L. L. Hernandez¹
Department of Dairy Science, University of Wisconsin, Madison 53706

Clinical hypocalcemia: 10%

Subclinical hypocalcemia: 28%

Ketosis: 50%



Conclusion: Circulating 5-HT is positively correlated with Ca and PTHrP concentrations on d 1 of lactation





Hypothesis

Increasing circulating 5-HT will be beneficial
for calcium and energy metabolism of
lactating dairy cows



5-HTP dose experiment

4x4 Latin square

> 300 DIM / 45 lbs milk

I.V. infusion of 4 5-HTP doses for 4 days



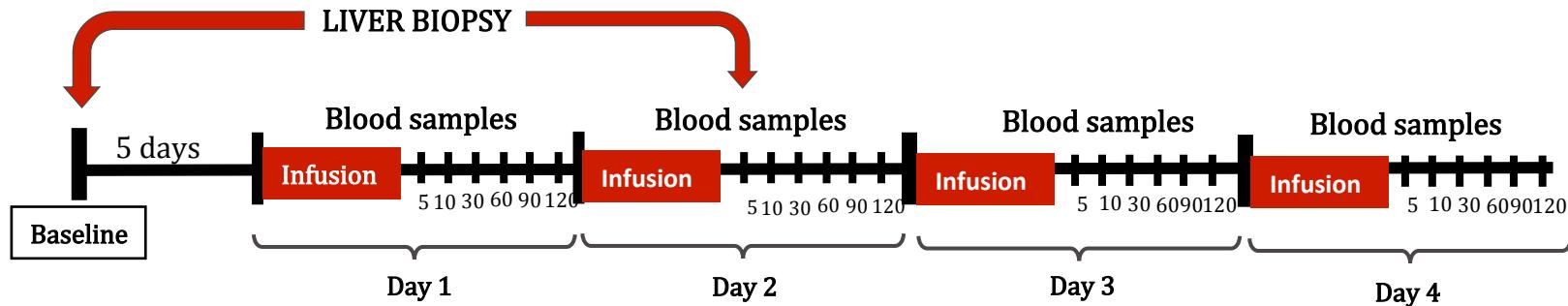
Vitals

Serial blood samples

Urine pre and post-infusion

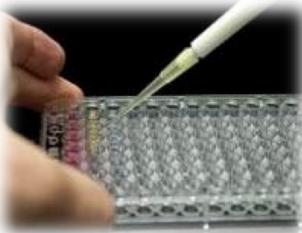
Liver biopsies

Safe? Applicable?





Laboratory measurements



5-HT
Glucose
NEFA
BHBA
Calcium
PTHRP
Hepatic gene expression

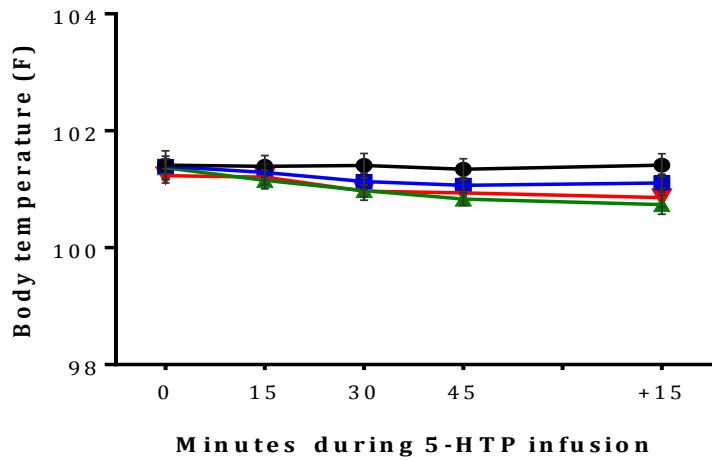
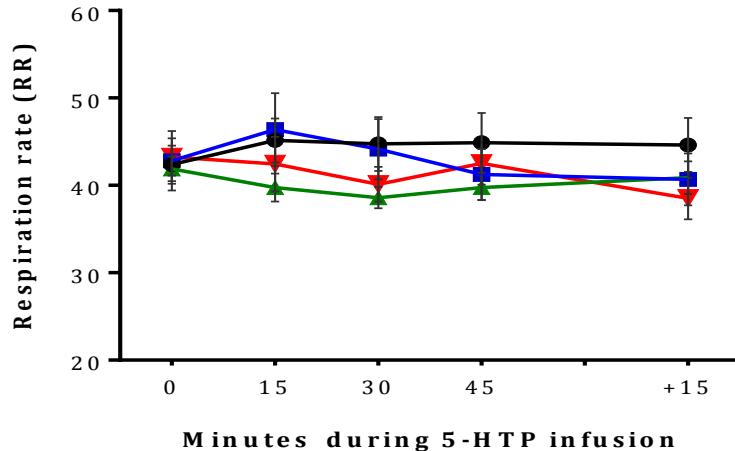
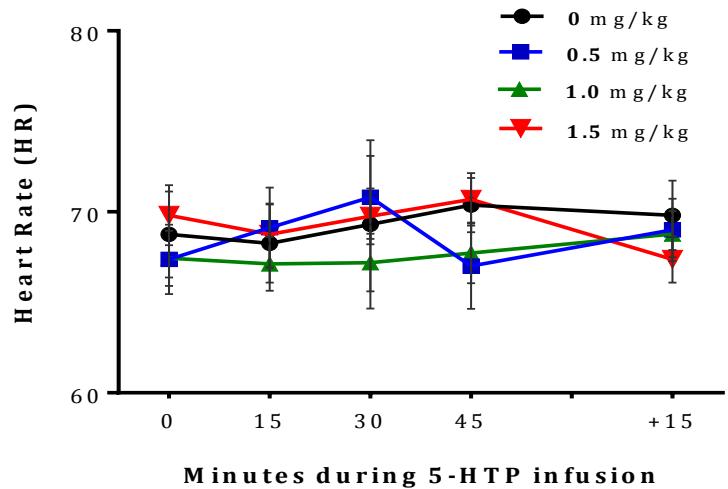


Statistical analysis (R software)

$$y = \text{cow} + \text{period} + \text{trt} + \text{day} + \text{time} + \text{trt} * \text{day} + \text{trt} * \text{time}$$



Cow Vitals

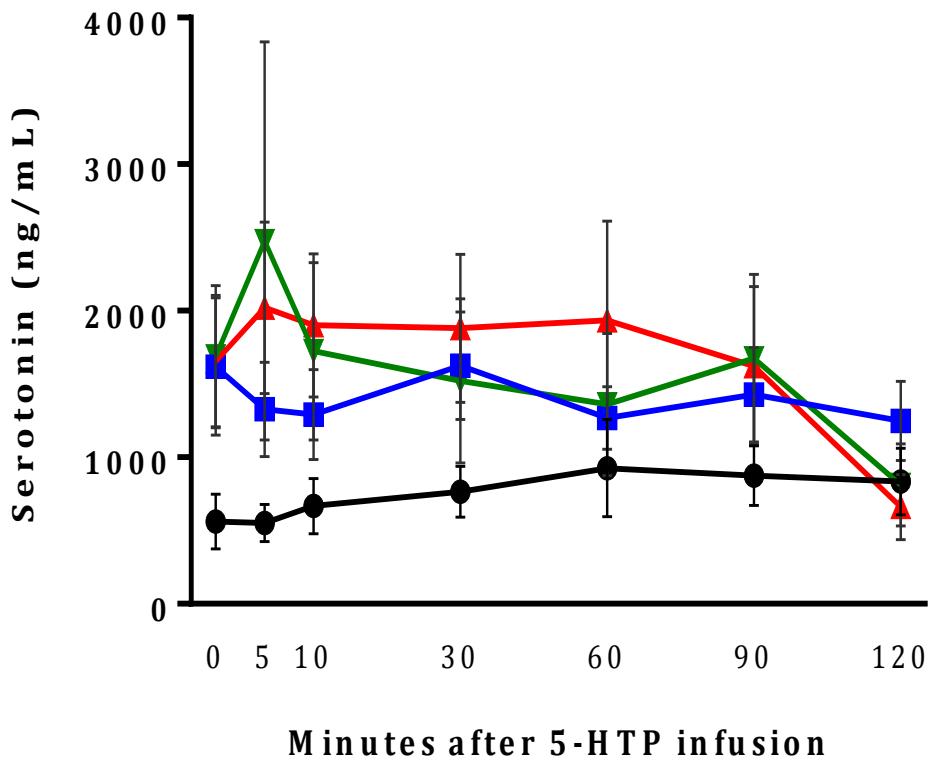


✓ 5-HTP infusion is safe

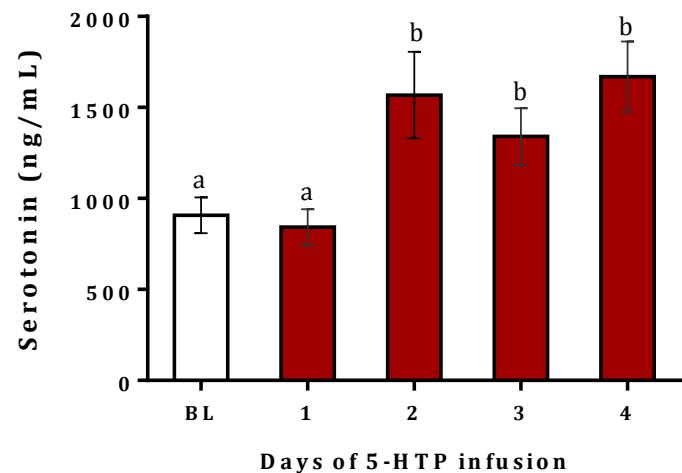


5-HT

Dose and time effect



Day effect



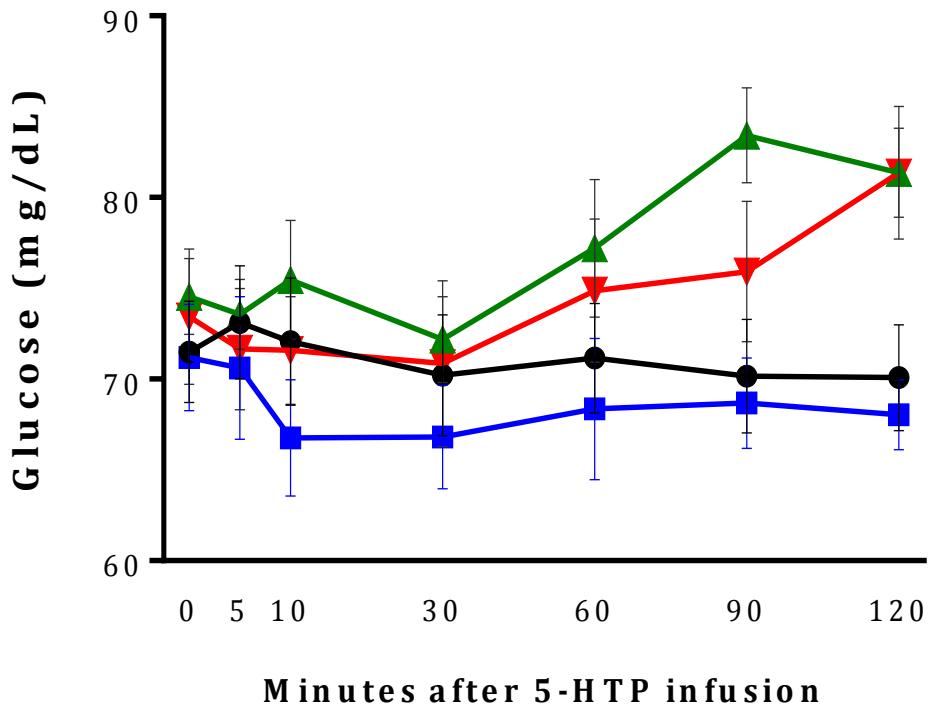
✓ Increase was sustained over time

✓ 5-HTP infusion increases cow's systemic 5-HT

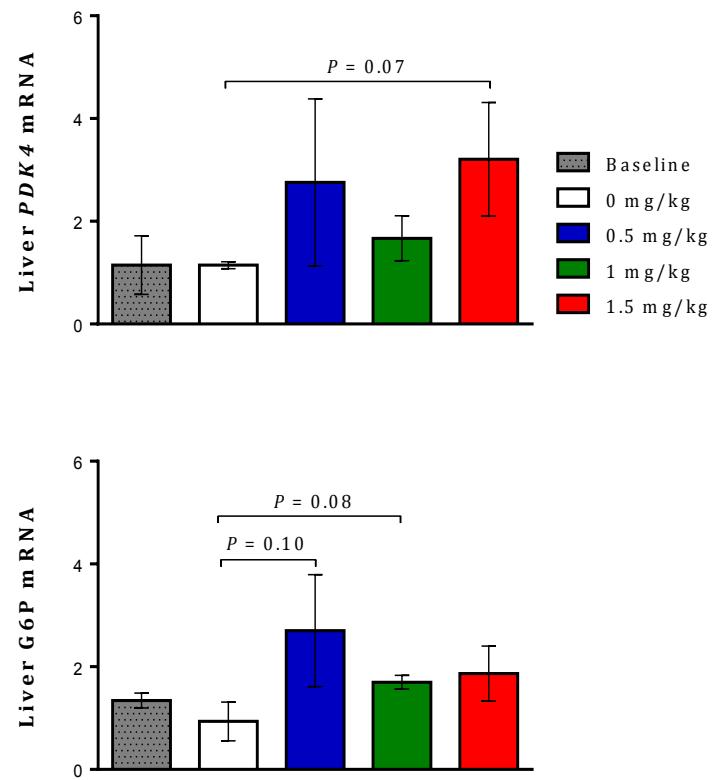


Glucose

Dose and time effect

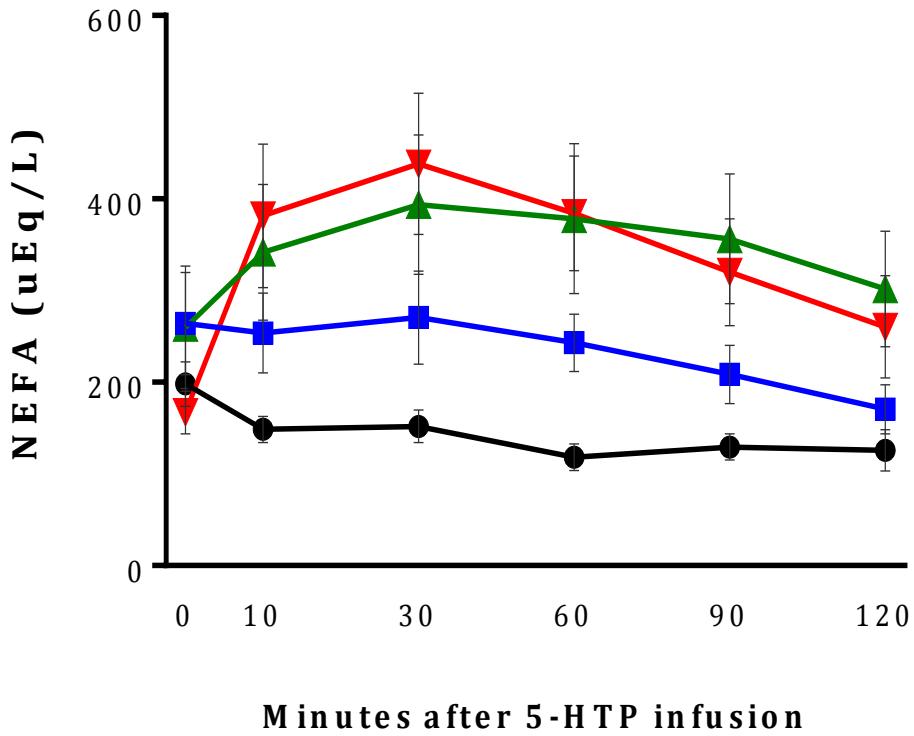


Hepatic mRNA Expression



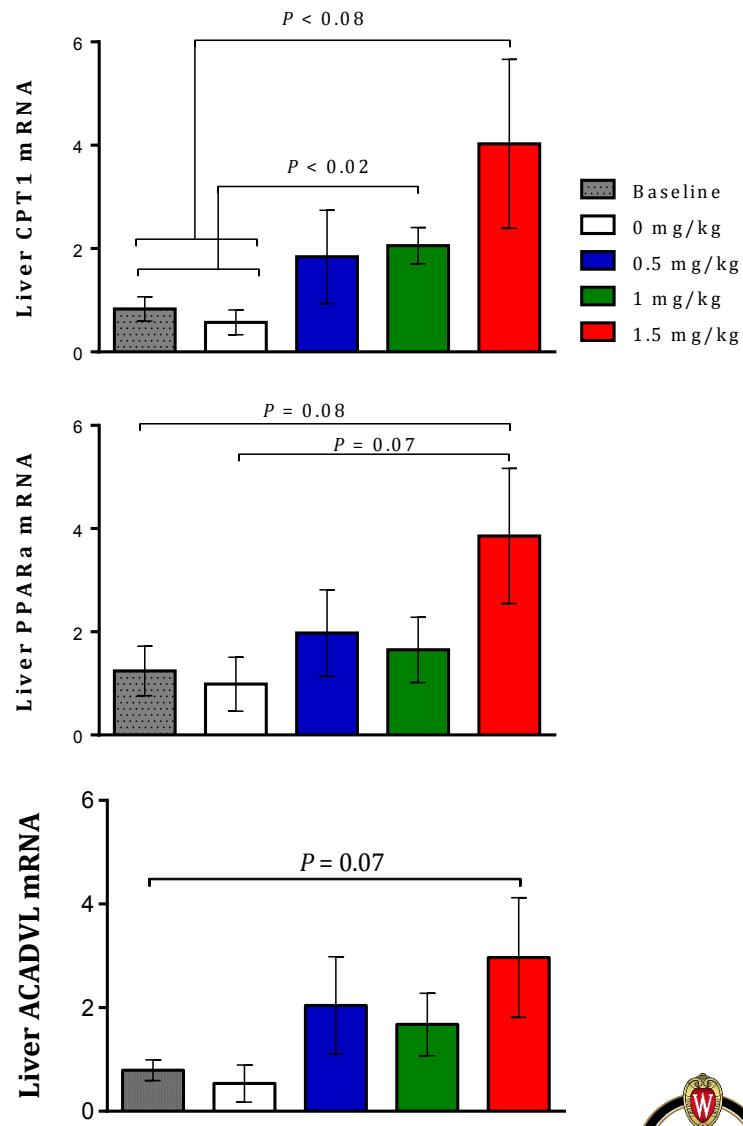
NEFA

Dose and time effect



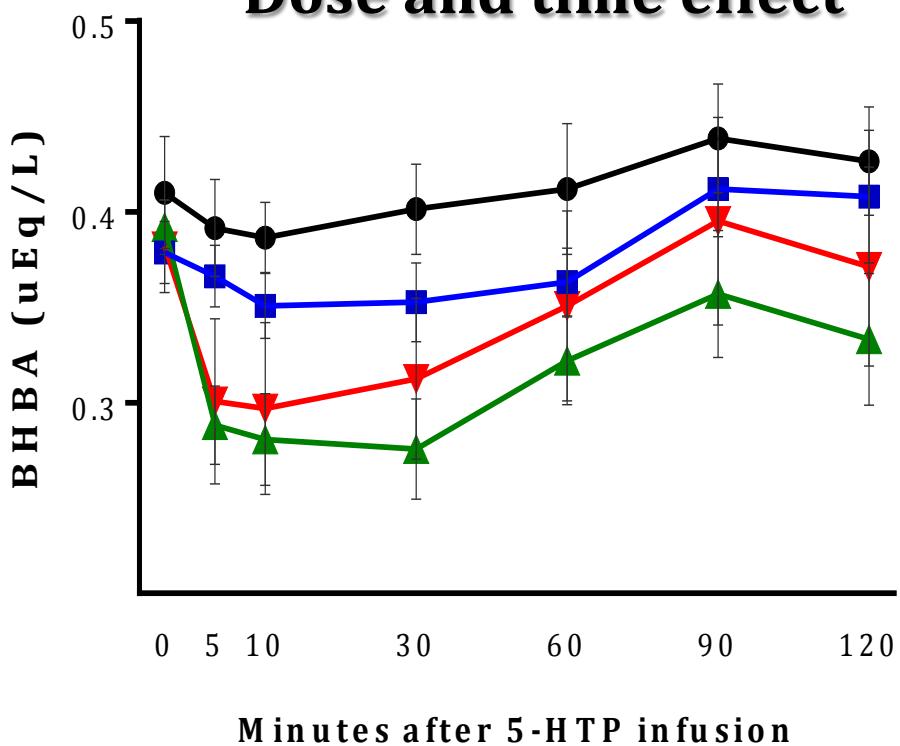
Day effect:
D3 and D4 > D1 and D2

Hepatic mRNA Expression

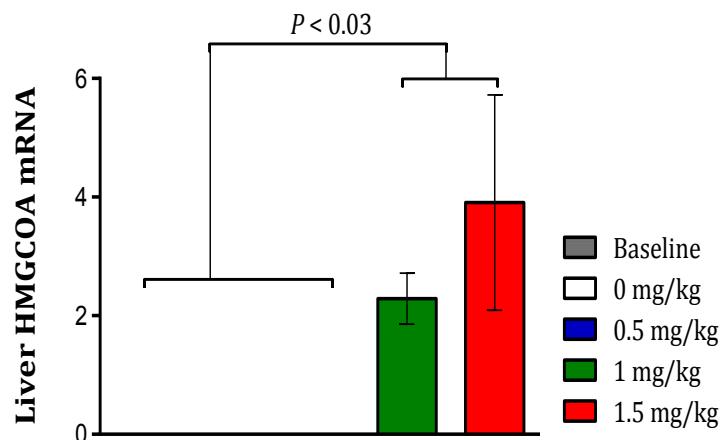


BHBA

Dose and time effect



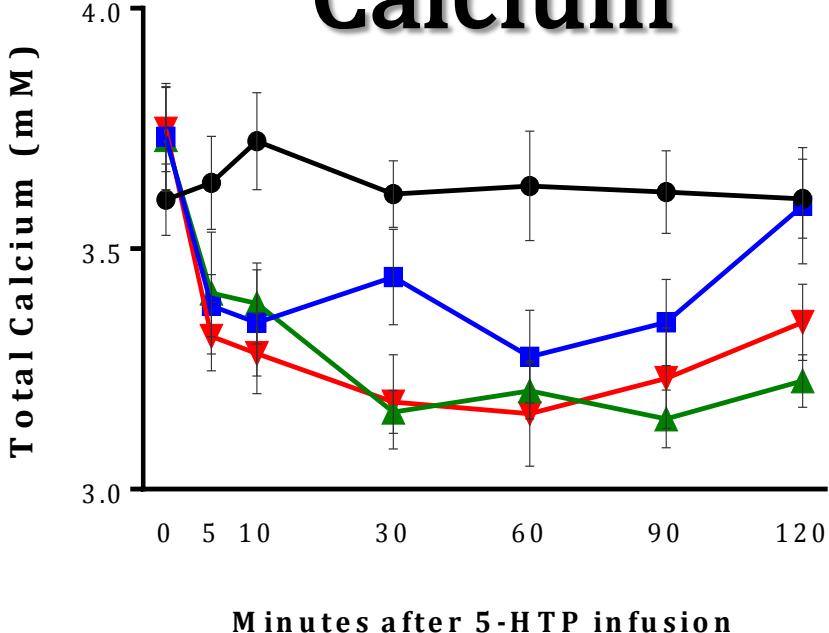
Hepatic mRNA Expression



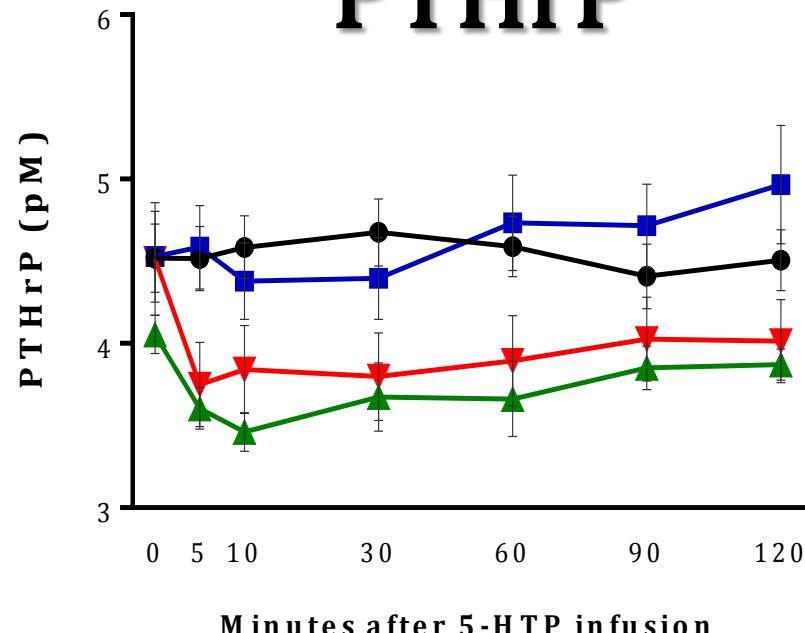
Day effect:
D2, D3, D4 < D1



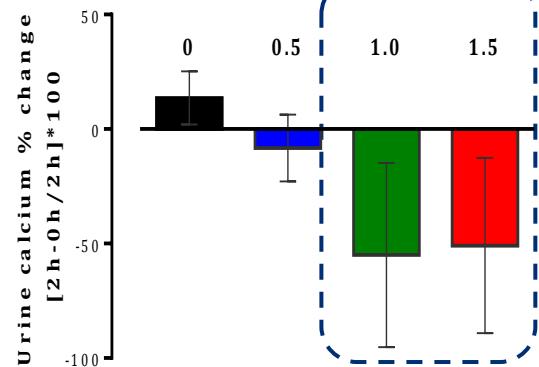
Calcium



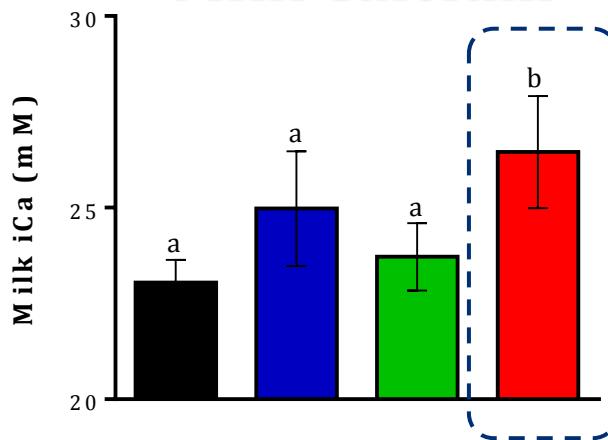
PThrP



Urine Calcium



Milk Calcium



Summary and final remarks

5-HTP administration to cows:

- (1) Is safe
- (2) Increases cow's systemic 5-HT
- (3) Increases blood GLUCOSE and NEFA
- (4) Decreases blood BHBA
- (5) Increases CALCIUM uptake by the MG (milk) and decreases CALCIUM elimination in urine

Further research

- ✓ Transition cows
- ✓ 5-HTP to prevent transition related disorders?



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Final summary

