Effects of Prenatal and Postnatal Nutrition on the Concentration of Neuropeptide Y in the Third Ventricle Cerebrospinal Fluid in Beef Heifers

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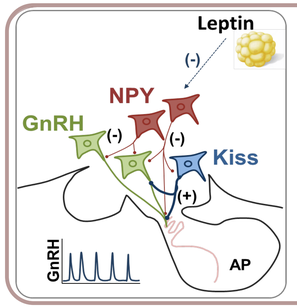
Introduction

- Gestational and postnatal nutrition can program developmental changes in the offspring that impact the reproductive neuroendocrine system.
- Leptin plays a crucial role in relaying metabolic status to the hypothalamus. Neurons expressing the orexigenic neuropeptide Y (NPY) contain the leptin receptor and comprise an important hypothalamic pathway that inhibits GnRH secretion before puberty and during periods of energy deficiency.



Role of NPY Neurons in the Arcuate Nucleus of the Hypothalamus:

- Inhibit GnRH/LH secretion
- Delay pubertal development
- Stimulate appetite

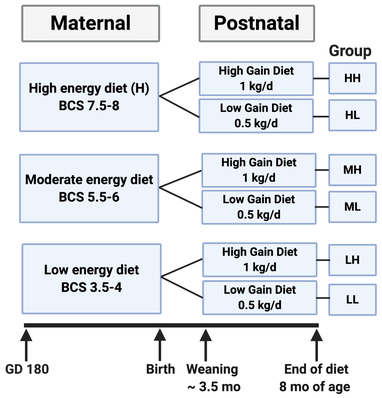
Hypothesis

Using the bovine model, we tested the hypothesis that maternal nutrition during the second and third trimesters of gestation and dietary energy intake during the juvenile period interact to affect concentrations of neuropeptide Y after fasting and in response to leptin administration in heifer offspring.

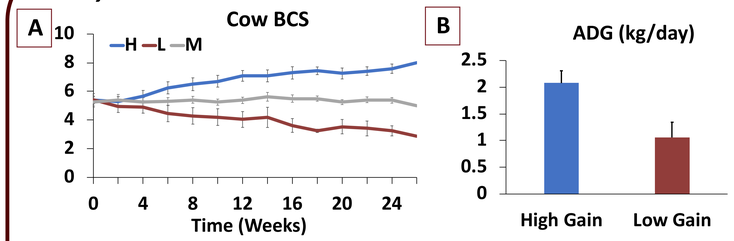
Materials and Methods

Animal Procedures

Bos indicus-influenced beef heifers were developed based on a 3x2 factorial arrangement of pre- and postnatal dietary treatments. At the second trimester of gestation, pregnant cows were fed to reach obese, moderate, or very thin BCS. Once heifer offspring were weaned, they were fed either with a high gain diet (1 kg/d) or a low gain diet (0.5 kg/d) until 8 mo of age.

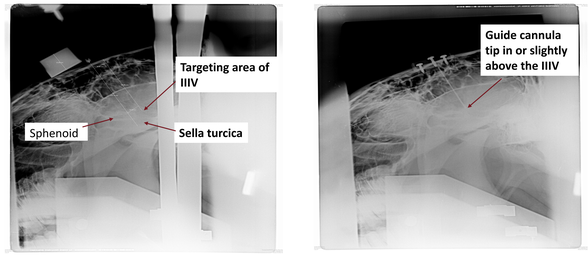


Dietary Model



(A) Dams BCS during the last two trimesters of gestation. Each dietary treatment resulted in the desired BCS (L<M<H; $P < 0.0001$). (B) The average daily gain (ADG) of the heifers from weaning until the end of the dietary treatment at 8 mo of age (LG<HG; $P < 0.0001$).

Third Ventricle Cannulation Surgery

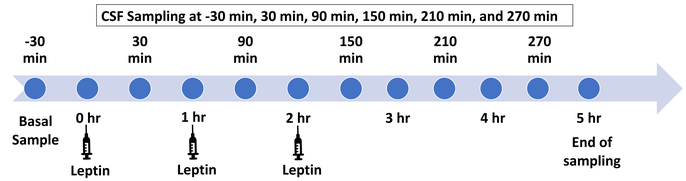


Pre-op digital X-ray of the brain in a heifer with measurements indicating location of IIIV target

Post-op digital X-ray of the brain in a heifer with cannula placed just above the IIIV.

Intensive Sampling

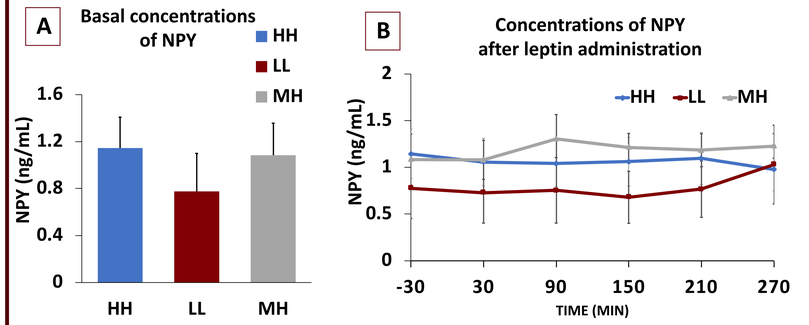
A subgroup of the heifers (HH, n=6; MH, n=6; LL, n=6) was ovariectomized and received subcutaneous estradiol implants. Guide cannulas were surgically inserted in the third ventricle of the brain. Heifers were fasted for 54 hr and then received IV leptin, with CSF collected throughout the procedure.



EIA

The concentrations of NPY in the third ventricle CSF were determined using an enzyme Immunoassay (EIA). Recovery of added mass and parallelism of serial dilutions were performed to validate the assay.

Results



Basal and post-leptin concentrations of NPY in the CSF. (A) CSF samples collected at -30 min were used to determine basal concentrations of NPY after fasting. There were no significant effects of treatment on basal concentrations of NPY. (B) Leptin Injections were administered at 0 hr, 1 hr, and 2 hr in order to test the effect of IV leptin administration on NPY concentration in the CSF. Similar to observed for basal levels of NPY, there were no significant effects of treatment on post-leptin concentrations of NPY in the CSF.

Conclusion

- The interaction of prenatal and early postnatal nutrition did not affect basal concentrations of NPY after fasting in the third ventricle CSF.
- Leptin treatment had no effect on CSF concentrations of NPY and did not differ among groups. However, despite marked elevations in plasma leptin, separate analyses (Maia et al. Proc. Soc. Study Reprod., 2020) suggest that transfer across the blood-brain-barrier did not occur in detectable quantities in this model. This likely explains the lack of effect on NPY concentrations in CSF.

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