Hepatic gluconeogenesis in dairy cows as affected by dietary starch level and supplementation with monensin during early lactation

M. M. McCarthy[1], T. Yasui[1], S. H. Pelton[1], C. M. Ryan[1], G. D. Mechor[2], and T. R. Overton[1]

[1]Department of Animal Science, Cornell University, Ithaca, NY 14853

[2]Elanco Animal Health, Greenfield, IN, 46140

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Introduction

- Hepatic glucose production nearly doubles within a few days of calving, as compared with prepartum glucose output (Reynolds et al., 2003)
  - Propionate produced via fermentation of starch in the rumen is the main precursor for hepatic glucose production
  - Monensin is a commonly used feed additive that increases ruminal propionate production

Objective

- To determine if increasing starch level and/or feeding monensin postpartum would increase hepatic capacity to utilize propionate for gluconeogenesis

Materials & Methods

- Holstein cows were fed a high starch (26.2%) or low (21.5%) starch early lactation diet with 0 or 450 mg/d monensin topdress in a 2 × 2 factorial arrangement
  - Multiparous (n=37) and primiparous (n=17)
  - Prepartum controlled energy diet with either 0 or 400 mg/d monensin topdress, depending on early lactation treatment assignment
- Liver tissue was sampled via percutaneous trocar biopsy (Veenhuizen et al., 1991) from cows on d 7 ± 4 postpartum
- Tissue samples were used immediately for in vitro determination of gluconeogenesis and oxidative metabolism of propionate using a [1-^{14}C]propionate label (Piepenbrink et al., 2004)

Statistical Analysis

- Statistical analysis conducted using the Proc Mixed procedure in SAS
- All 2 way interactions analyzed

Results

Figure 1. Effect of early lactation starch and monensin treatment on hepatic capacity to convert [1-^{14}C]propionate to CO_2 and glucose in vitro

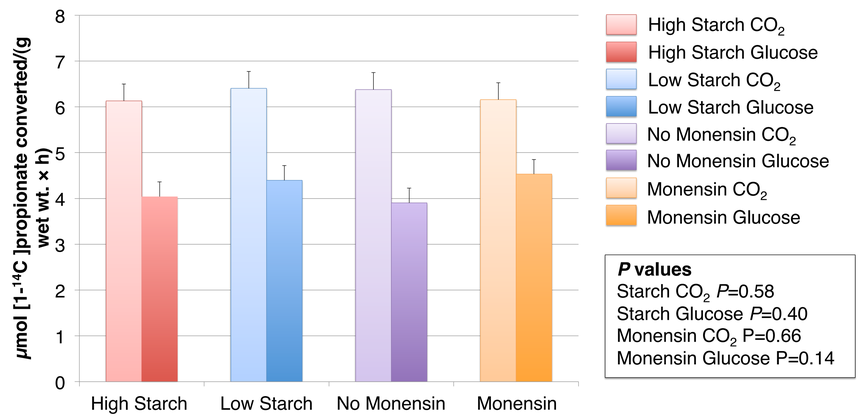


Figure 2. Primiparous cows have increased hepatic capacity to utilize [1-^{14}C]propionate for gluconeogenesis and oxidation compared to multiparous cows

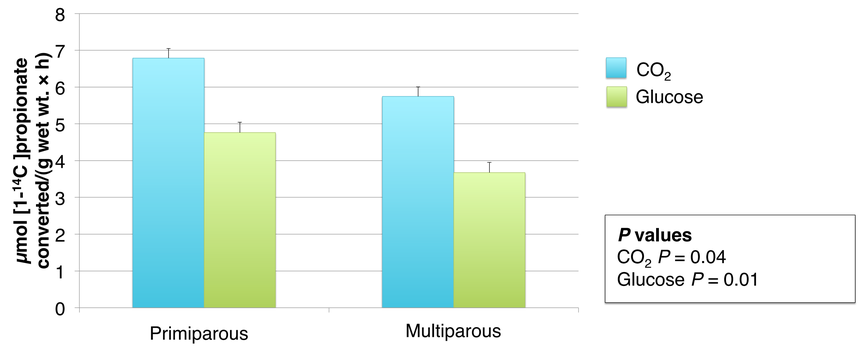
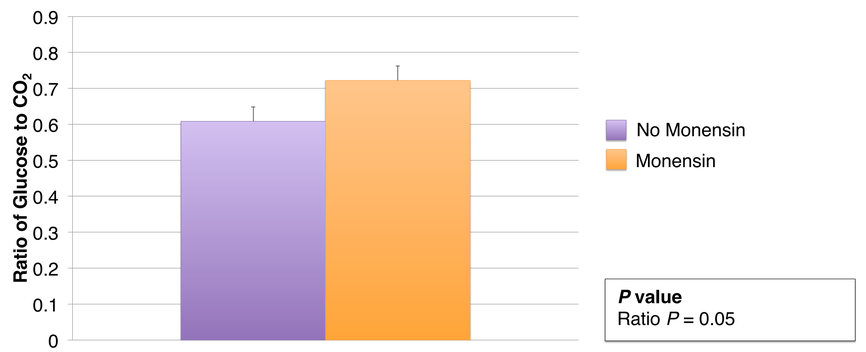


Figure 3. Transition period monensin treatment increases hepatic glucose to CO_2 ratio



Results and Discussion

Ratio of glucose to CO_2

- [1-^{14}C]propionate label randomizes in the TCA cycle
- 1 mole of propionate that forms oxaloacetate should yield:
  - 0.5 moles of labeled glucose
  - 0.5 moles of labeled CO_2
- An increase in this ratio suggests greater efficiency in propionate utilization for glucose synthesis (Knapp et al., 1992)

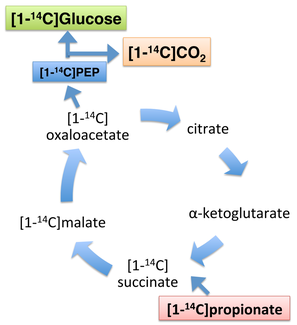


Figure 4. Randomization of [1-^{14}C]propionate label

- No effects of starch on hepatic capacity to convert [1-^{14}C]propionate to CO_2 or glucose
- Primiparous cows had greater capacity per unit of tissue to utilize [1-^{14}C]propionate for oxidation and gluconeogenesis than multiparous cows
- Cows fed monensin tended to have greater capacity to convert [1-^{14}C]propionate to glucose and had a greater ratio glucose to CO_2 than cows not fed monensin

Implications

- Fresh period starch level does not appear to affect hepatic propionate utilization for gluconeogenesis or oxidation
- Primiparous and multiparous cows have different capacities to utilize propionate
- Feeding monensin during the transition period increases the cow's ability to convert propionate to glucose

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