Effects of a naturally occurring caffeine product delivered orally on rate of caffeine absorption and associated metabolic parameters in the bovine neonate

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Introduction

A significant amount of published research has been conducted in the field of human medicine investigating the therapeutic effects of administering caffeine to infants. Consequently, caffeine is very commonly used as a stimulant, particularly in the NICU. However, little work exists investigating the application of caffeine in bovine neonates, specifically those with low vigor. The study objectives were first to determine absorption rate and subsequent blood concentration of caffeine in calves administered a viscous oral product containing naturally occurring caffeine (Calf Perk®, TechMix LLC, Stewart, MN). The second objective was to determine if caffeine alters any associated effects on metabolic variables of the calf such as circulating glucose, insulin and NEFA concentrations.

Materials and methods

Six Holstein × Angus-cross bull calves were outfitted with indwelling jugular catheters 40 minutes prior to treatment administration. All calves were 1-3 days of age, had received a labeled colostrum replacer, had a milk replacer feeding approximately 1.5 hours prior to study initiation, and were not offered access to any nutritional supplementation during the experimental period. All calves were healthy, not scouring and not treated for any known disease or disorder. All calves had blood samples collected prior to treatment administration (T0) followed immediately by all calves receiving a single 15.7 mL dose of Calf Perk (CP). Blood samples were obtained at T0, 10, 20, 30 and 60 minutes relative to CP administration. Serum aliquots were collected and frozen for later analysis. Effects of time were assessed using PROC MIXED (SAS Inst. Inc., Cary, NC). Each animal's respective parameter was statistically analyzed using repeated measures with a spatial power covariance structure for caffeine, insulin, glucose and NEFA concentrations. Time was treated as the repeated effect and calf the random variable.

Results

Serum caffeine concentrations were increased 12-fold at T10, and 14-fold by T60 ($P < 0.001$). There were no observed changes in blood glucose over time ($P = 0.47$). However, circulating insulin concentration tended to be higher following CP administration ($P < 0.09$) with a 32% increase at T20 compared to T0. There was no difference in circulating NEFA content ($P = 0.98$)

Significance

The rapid infiltration of caffeine into the blood stream demonstrates the oral mucosa being the more probable site of absorption, facilitated by the viscous formulation, rather than typical lower GI uptake. A tendency for elevated circulating insulin with no corresponding decrease in blood glucose suggests either enhanced glucose turnover or a mild insulin insensitivity. Caffeine administration in humans, supported by published research, has reported similar insulin and blood glucose observations. Further research opportunities are necessary to better understand the metabolic outcomes of naturally occurring caffeine and determine CP's effect on calves with a low vigor score.

