The effect of high-carbohydrate feeding and body condition on pancreatic histomorphometry in mixed-breed ponies

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Introduction

- Hyperinsulinemia-associated laminitis is a debilitating disease of equids causing significant morbidity, mortality, and economic loss to the equine industry
- The endocrine pancreas is the source of endogenous insulin and presumed to be dysfunctional in hyperinsulinemic animals
- Mechanisms that influence the regulation of insulin release at the level of the pancreas are currently poorly characterized in equids
- Understanding equine endocrine pancreatic function, including how function changes in response to animal management (diet, body condition), is critically important to further elucidate the pathophysiology of hyperinsulinemia-associated laminitis with the goal of developing effective treatment strategies

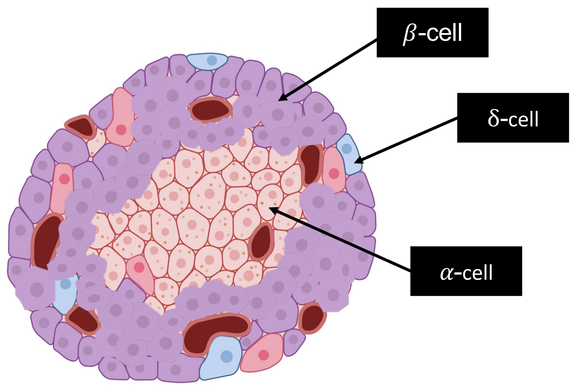


Figure 1. Equine pancreatic histomorphology: The normal equine endocrine pancreas is composed of insulin secreting β-cells, which form a mantle around the islet. These β-cells comprise a majority of the endocrine cell population of the islet. The glucagon secreting α-cells are the second most abundant cell population in the islet and are located centrally, surrounded by the β-cells. The somatostatin secreting δ-cells are located discontinuously throughout the periphery of the islet.

Objective

- Characterize changes in the equine endocrine pancreas in response to dietary carbohydrate challenge in lean and obese equids, using immunohistochemistry to evaluate pancreatic morphology
- The focus of the current study was to assess pancreatic insulin, glucagon, and somatostatin expression in obese/lean ponies fed a control diet or a high non-structural carbohydrate (NSC) diet

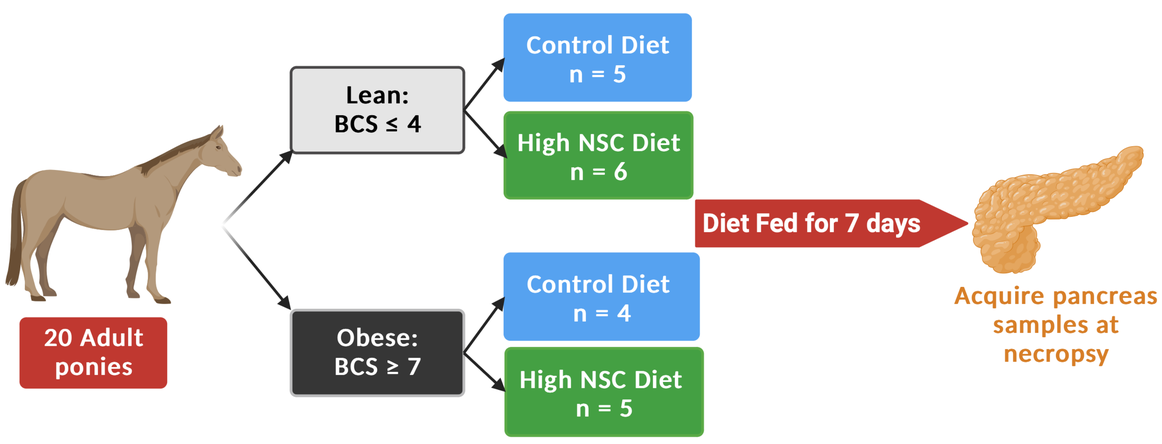
Hypothesis

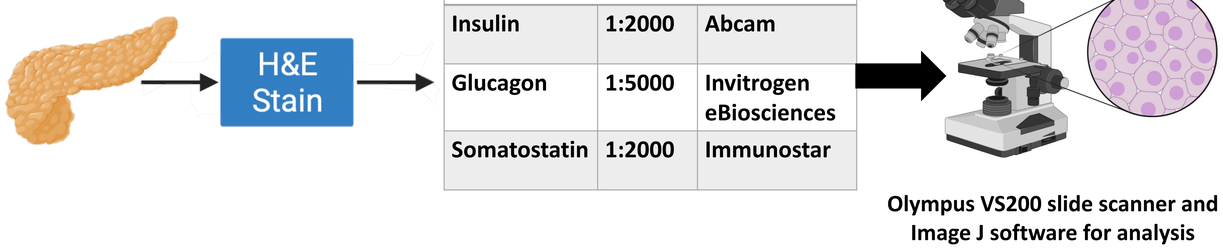
- Dietary NSC content and body condition will influence histomorphometric characteristics of the endocrine pancreas in ponies
- Short-term high-NSC feeding of ponies will alter pancreatic expression of factors known to regulate insulin secretion

Materials and Methods

Animals:

Control Diet: 1.8 g/kg/day ethanol-soluble CHO --- High-NSC Diet: 8 g/kg/day ethanol-soluble CHO





Statistical Analysis:

- Normality assessed by the Shapiro-Wilk and D'Agostino and Pearson omnibus normality tests
- Two-way ANOVA followed by a Bonferroni post-test was used to compare histomorphometry data between groups (Lean Control, Lean High-NSC, Obese Control, Obese High-NSC)
- Pooled histomorphometry data comparing control-fed and high-NSC diet fed animals were analyzed using an unpaired t-test or Mann-Whitney test based on normality
- Spearman rank correlation was performed between plasma [insulin] and SA measurements for insulin, glucagon, and somatostatin
- Statistical significance accepted at $P < 0.05$

Results

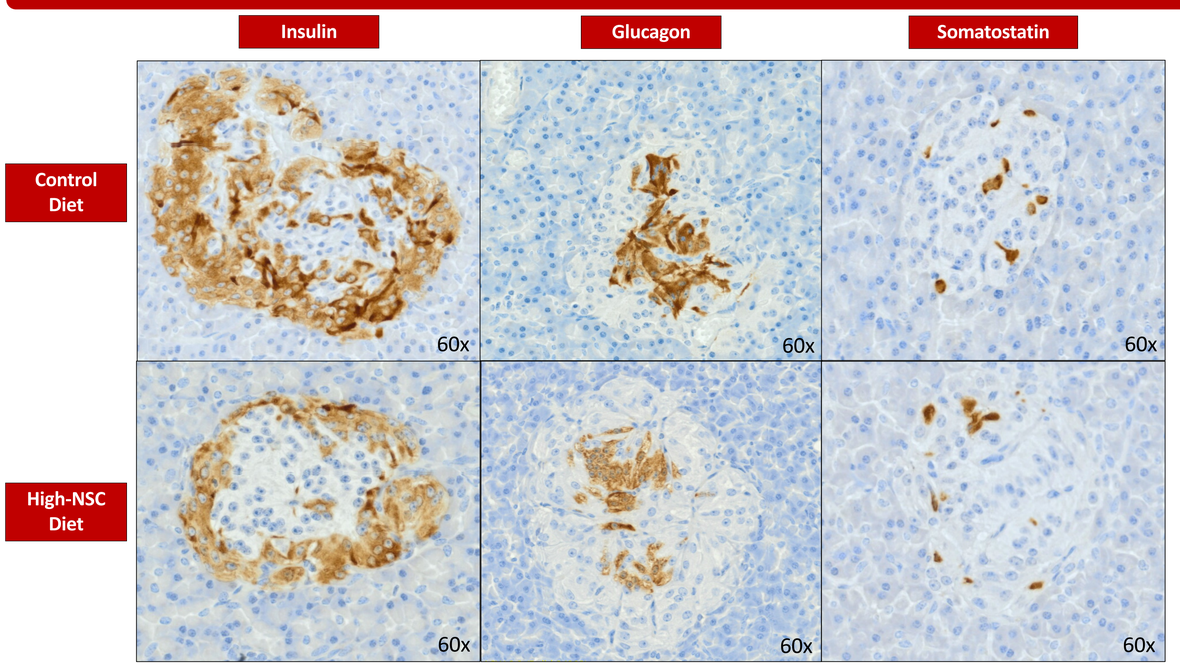


Figure 2 : Representative photomicrographs of pancreatic islet cells from ponies fed a control diet or a high-NSC diet and were immunohistochemically stained for insulin, glucagon, and somatostatin detection

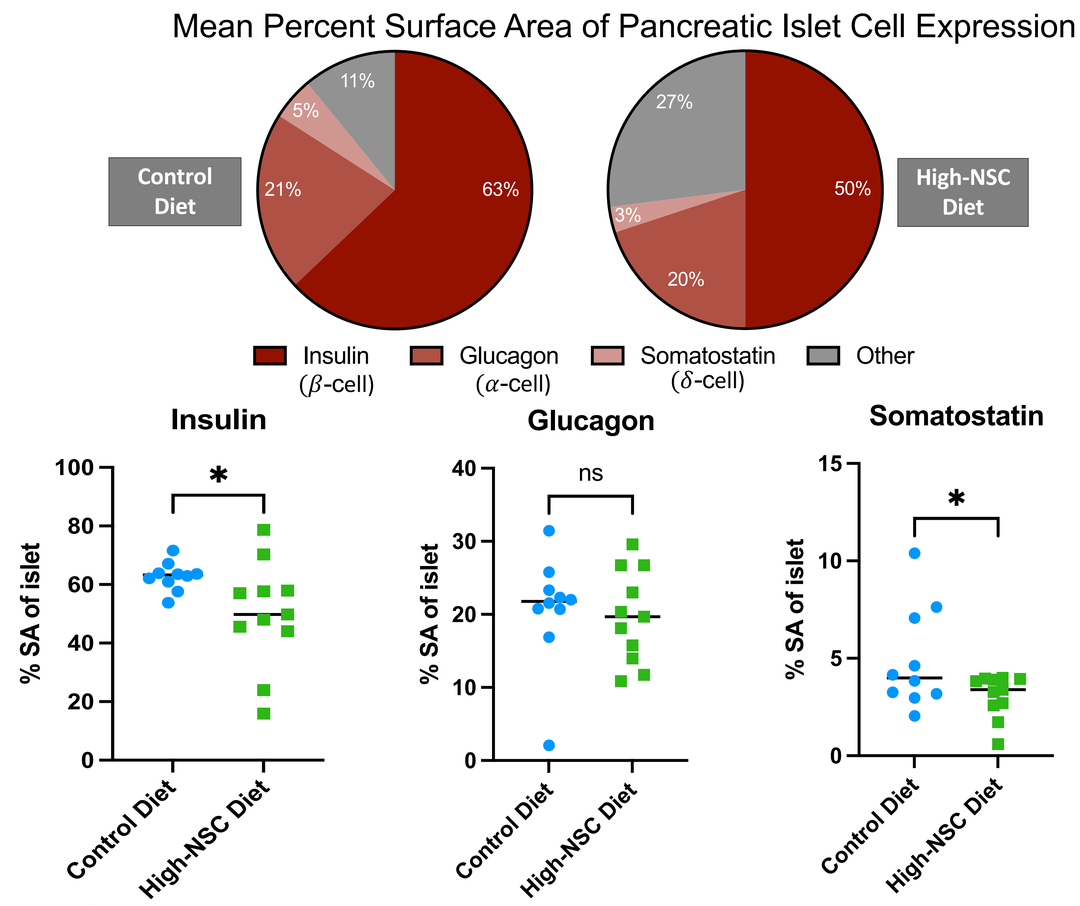


Figure 3: Pancreatic islet cell expression of insulin, glucagon, and somatostatin from ponies fed a control diet or a high-NSC diet. ***P < 0.05**

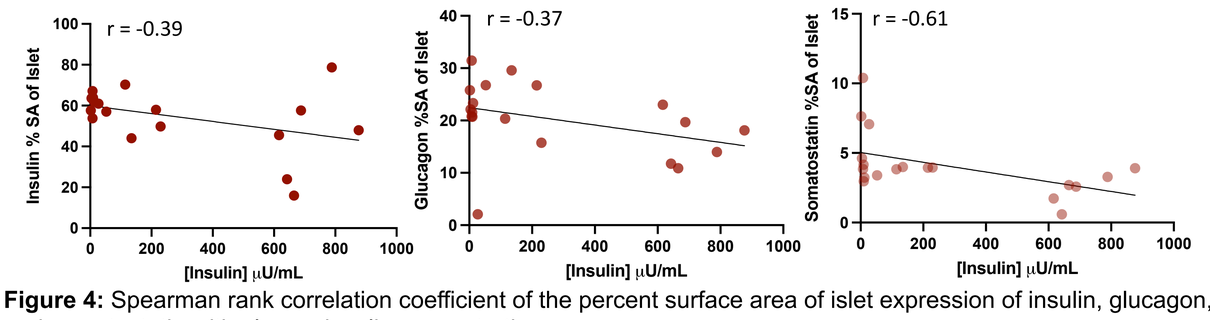


Figure 4: Spearman rank correlation coefficient of the percent surface area of islet expression of insulin, glucagon, and somatostatin with plasma insulin concentrations

Conclusions

- Ponies fed a ***high-NSC*** diet for 7 days demonstrated an ***altered pancreatic histomorphology***
- ***Insulin*** and ***somatostatin*** expression were ***reduced*** in ponies fed a ***high-NSC diet*** → reduction in β-cell and δ-cell surface area, respectively
- Somatostatin expression was lower in ponies fed a high-NSC diet, which may contribute to the development of hyperinsulinemia
- A reduction in pancreatic insulin expression despite elevated plasma [insulin] suggests the ***possibility of reduced insulin clearance***
- There were no significant differences associated with BCS (data not shown)

Future Directions

- Perform immunohistochemical analysis on the archived pancreatic samples from the ponies in the current study for insulin receptor, leptin, leptin receptor, IGF-1 receptor, and GLP-1 receptor

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Disclosure of Conflict of Interest: None

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