Rearing protocol during the first three weeks of life effects histology of pancreatic beta cells in male calves

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Outline

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1. Ad libitum feeding

Conventional feeding

- 10 % of BW of milk/milk replacer per day → 4-6 L/day

Ad libitum feeding

- at least 20 % of BW of milk/milk replacer per day → 10-12 L/day
- advantages:
  - higher weight gain (Khan et al., 2007)
  - lower morbidity and mortality rates (Godden et al., 2005)
  - positive influence on behaviour (von Keyserlingk et al., 2007)
  - higher milk yield during the first lactation (up to 1.250 kg) (summarized in Kaske, 2009)
1. Insulin and pancreas

Insulin

- key hormone in the maintenance of glucose homeostasis
- impaired metabolism in dairy cows (massive glucose drain towards the udder)
- produced in the β-cells of the pancreas
- blood concentration differs during ad libitum and restrictive feeding (Maccari et al., 2014)
- in rats: perinatal nutritional stimuli permanently change the morphology of the pancreas (Holness et al., 2000)

Aim of the study

→ To determine long-term effects of early postnatal rearing conditions of calves on morphology of insulin producing pancreatic β-cells
2. Material and Methods

- male calves of Holstein Friesian breed were reared either intensively or according to a standard protocol in the first 3 weeks of life

**Intensively reared calves (INT; n=21)**

- Day 1: individual hutches
- Milk ad libitum
- Day 24: group pen
- 6 L MR

**Conventionally reared calves (CON; n=21)**

- Day 1: individual hutches
- 4 L milk
- Day 8: group pen
- 6 L MR

- Weaning: day 29 – 70 of life
2. Material and Methods

• data collection:
  – intake of milk/MR and calf starter
  – body weight (birth, weekly up to wk 10 of life, slaughter)

• slaughtering at an age of 9 months

• pancreatic tissue was removed and examined by histological and immunohistochemical techniques:
  – hematoxylin eosin stain
  – antibody (insulin) staining
2. Material and Methods

• **Number of islets of Langerhans**
  - pictures of immunostained preparations ("Axiophot", Zeiss)
  - 6 – 18 pictures of each calf (depending on cross-section size of preparation)
  - number of Islets of Langerhans was counted

• **Area of β-cells**
  - pictures of immunostained preparations ("Eclipse E600", Nikon)
  - 5 pictures each of 18 calves (INT n=9; CON n=9)
  - brown stained areas were marked red and area was calculated (NIS-Elements Basic Research 3.2, Nikon)

• **Statistical analyses**: SAS Version 9.3 → GLM an MIXED procedure
3. Results

Feed intake
- higher milk consumption during the first three weeks of life in intensively reared calves (INT: 196 kg, CON: 102 kg; P<0.001)
- no difference in calf starter intake (INT: 0.94 kg, CON: 0.84 kg; P=0.28)

Body weight
- birth weights were similar (43.9 ± 1.5 kg vs. 44.1 ± 1.5 kg, P = 1.0)
- weekly body weights higher in calves reared intensively (P < 0.001)
- body weight at slaughter did not differ significantly (319 ± 5 kg vs. 309 ± 5 kg, P = 0.18)
3. Results

Blood glucose and insulin concentration

- Differences in the serum glucose and plasma insulin concentration during the time of different feeding
3. Results

Number of islets of Langerhans and area of $\beta$-cells

- significant higher numbers of Islets of Langerhans in calves reared intensively
  - $9.1 \pm 0.3$ vs. $7.8 \pm 0.3$ islets ($P = 0.002$)

- no significant differences in the area of $\beta$-cells between both treatment groups
  - $102,799 \pm 8,193 \, \mu m^2$ vs. $85,699 \pm 8,193 \, \mu m^2$ ($P = 0.14$)

*Immunhistochemical presentation of the Islets of Langerhans*
4. Discussion

Feed intake

• intensively reared calves:
  ✓ higher nutrient intake during the first three weeks of life
  ✓ higher body weight gain during the first 10 weeks of life
  ✓ differences in body weight at slaughter were not as great as expected (later lung diseases?)
  ✓ higher blood glucose and insulin concentration after three weeks of life
4. Discussion

Number of islets of Langerhans and Area of $\beta$-cells

- neonatal period: replication and regeneration of $\beta$-cells is high; number and size of newly formed islets are influenced by nutritional stimuli
  - control mechanisms are not fully understood
  - maybe important: Insulin-like growth factors (IGFs)

- no differences in the area of $\beta$-cells
  - limited number of animals
  - no standardized method

- altered histology of pancreatic $\beta$-cells $\rightarrow$ Metabolic programming
  - The organism is able to modulate „biological switches“ to adapt itself to altered environments during early periods in life.
Thank you for your attention!