Early postnatal plane of nutrition affects subsequent milk production of Holstein calves

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During the last decades, a restrictive provision of milk or milk replacer (MR) to newborn calves was (and is still) common practice on cattle farms.

- Concerns about delayed intake of concentrates/roughage, delayed rumen development, higher incidence of diarrhea, and higher costs.

- Recently, a re-evaluation of the restricted feeding protocol during the very first weeks of life has started.
Direct effects of „accelerated early nutrition“, „enhanced nutrition“, „intensified nutrition“ or „biologically appropriate growth“ during the first weeks of life

- improved welfare
- better constitution
- improved behaviour
- comparable costs
- comparable incidence of diarrhea
- improved feed efficiency
- comparable rumen development
- comparable concentrate/roughage intake
- higher weight of mammary parenchyma

Hammon et al., 2002; Brown et al., 2005; Godden et al., 2005; Khan et al., 2007; von Keyserlingk et al., 2009; Khan et al., 2011; Maccari et al., 2014; Prokop et al., 2015
Because of feeding intensity during early life on subsequent performance

<table>
<thead>
<tr>
<th>Reference</th>
<th>Groups</th>
<th>Duration of different feeding</th>
<th>Diff. Milk [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foldager / Krohn, 1994</td>
<td>suckling/restrictive</td>
<td>48 days</td>
<td>+ 1.402</td>
</tr>
<tr>
<td>Bar-Peled et al., 1998</td>
<td>suckling/MR</td>
<td>60 days</td>
<td>+ 453</td>
</tr>
<tr>
<td>Ballard et al., 2005</td>
<td>milk ad lib./conv. MR</td>
<td>35 days</td>
<td>+ 1.250</td>
</tr>
<tr>
<td>Rincker et al., 2006</td>
<td>intens. MR/conv. MR</td>
<td>42 days</td>
<td>n.s. (60 DIM)</td>
</tr>
<tr>
<td>Moallem et al., 2006</td>
<td>intens. MR/conv. MR</td>
<td>60 days</td>
<td>1.134</td>
</tr>
<tr>
<td>Drackley et al., 2007</td>
<td>intens. MR/conv. MR</td>
<td>35 days</td>
<td>+ 921</td>
</tr>
<tr>
<td>Rincker et al., 2011</td>
<td>intens. MR/conv. MR</td>
<td>42 days</td>
<td>+ 291</td>
</tr>
<tr>
<td>Kiezebrink et al., 2014</td>
<td>intens. milk/restr. milk</td>
<td>48 days</td>
<td>n.s.</td>
</tr>
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</table>

MR=milk replacer
Effects of feeding intensity during the first 4 weeks on later life milk production - Experimental setup -

- Ad libitum feeding (N = 38)
  - Colostrum
  - Milk ad libitum
  - Milk replacer feeding - ad libitum
  - Weaning
  - TMR

- Restrictive feeding (N = 30)
  - Milk 2 x 2 L
  - Milk replacer feeding- 2 x 3 L/day
  - Weaning
  - TMR

✓ feed intake during the first 10 wks of life and during first lactation (n=37)
✓ milk yield and milk composition during first lactation

TMR = total mixed ration
Effects of feeding intensity during the first 4 weeks on later life milk production - Energy intake from milk/MR -

An intensified feeding during the first four weeks of life resulted in higher energy intakes from milk.
During the first weeks of life no significant concentrate intake was observed in both groups.
Effects of feeding intensity during the first 4 weeks on later life milk production
- Milk yield -

✓ no differences in first calving age between groups

Fat-corrected milk yield [kg]

Ad libitum feeding
Restrictive feeding

An intensified feeding during the first four weeks of life resulted in an increased FCM.

FCM (p<0.05):
Ad libitum feeding: 29.2 ± 0.4 kg/d
Restrictive feeding: 28.0 ± 0.4 kg/d
Effects of feeding intensity during the first 4 weeks on later life milk production
- Milk composition -

**Protein concentration (p=0.59):**
Ad libitum feeding (N=36): 3.30 ± 0.03 %
Restrictive feeding (N=31): 3.28 ± 0.03 %

**Fat concentration (p=0.64):**
Ad libitum feeding (N=36): 3.95 ± 0.07 %
Restrictive feeding (N=31): 3.90 ± 0.08 %

An intensified feeding during the first four weeks of life did not change milk composition over the whole lactation period.
An intensified feeding during the first four weeks of life resulted in higher roughage intakes during first lactation.
Conclusions

Ad libitum feeding during the first four weeks of life:

- resulted in higher feed intakes during the milk feeding period and during first lactation
- did not result in an earlier calving age
- programmed animals to produce more milk during first lactation
- further studies are needed to understand the underlying physiological mechanisms

Kühl, 2011
Thank you for your attention!

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An intensified feeding during the first three weeks of life resulted in higher weight gains.
Feeding intensity during the first three weeks of life affects glucose metabolism (male calves)

**Glucose [mmol/L]**

- Ad libitum feeding (N=24)
- Restrictive feeding (N=21)

**Insulin [µU/mL]**

- Ad libitum feeding (N=24)
- Restrictive feeding (N=21)

Maccari et al., 2014; Prokop et al., in revision
Feeding intensity during the first three weeks of life affects morphology of the pancreas

- during the fetal and the early postnatal period highest rate of replication and regeneration of β-cells from the ductal pancreatic epithelium
- nutrition influences the balance between β-cell proliferation and β-cell death

<table>
<thead>
<tr>
<th></th>
<th>Ad libitum</th>
<th>Control</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calves</td>
<td>21</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Number of islets</td>
<td>9.1 ± 0.3</td>
<td>7.8 ± 0.3</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Area of insulin stained cells (µm²)</td>
<td>107,180 ± 4,987</td>
<td>84,249 ± 4963</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>
And the costs?

✓ rearing until **day 152 pp** of the first lactation
✓ calculation of income and profits for US standards
✓ slight differences in the costs, but higher income in milk expected after the 152th day of lactation