Exogenous phytase for dairy cows

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Novozymes A/S, R&D
Ruminal degradation of phytate is incomplete

- Storage of P in grains and in protein seeds like soja and rape
  Park et al. 1999; Konishi et al. 1999

- Heat and formaldehyde reduce ruminal degradation

- Exogenous phytase increase digestibility and reduce excretion of P
  Kincaid et al. 2005; Knowlton et al. 2007
Low P availability -> high excretion

Ekelund et al. Livestock Prod. Sci., 2005
Type of phytase to use for dairy cows

- Available phytases are developed for pigs and poultry
- Which phytase type to use?
- How to apply it?
- How much to apply?
Test of phytases in an *in vitro* rumen fluid buffer system

- Four experimental phytases (mikrobial)
  - Phy1, Phy 2, Phy3: histidine acid phosphatase phytases
  - Phy 4: β-propeller phytase
- Modified Tilley and Terry (1963) method:
  - Feed + phytase incubated with ruminal fluid and buffer
Relative activity at 37 °C
Na-phytate as substrate
1 and 2 FTU per g of rapeseed cake

Brask-Pedersen et al. 2011, J. Dairy Sci.
Amount of enzyme protein per g feed

5 mg enzyme protein

150 mg enzyme protein

% InsP6

Incubation time, hours

control
Phy2
Phy4

Brask-Pedersen et al. 2011, J. Dairy Sci.
Sum up on *in vitro* experiment

- Exogenous phytase increased degradation of phytate in rapeseed cake
- Phy4 and Phy2 was most effective
- Phy2 had the highest specific activitet
- Phy2 was choosen for in vivo experiment
Test of Phy2 in fistulated dairy cows

- 4 fistulated Holstein dairy cows in 4 x 4 latin square design
- 3-week periods: two weeks adaptation, one week sampling
- Phytase in TMR:
  - None, low, medium or high
  - 23, 2023, 3982, 6015 FTU/kg DM
- Chromic oxide as flow marker

Ruminal phytase activity

Phytate flow from feed to duodenum

- Feedstuffs
- TMR
- Duodenum

Phytate flow from feed to duodenum

Degradation in two steps:
- In the TMR
- In the rumen
Degradation of phytate in the rumen

Phytase in TMR

- None: 86.4%
- Low: 93.7%
- Medium: 94.5%
- High: 96.3%
Degradation of phytate in the rumen

No further degradation in SI and LI
Sum up on *in vivo* experiment 1

- Exogenous phytase increased ruminal phytase activity
- Rumen and total-tract degradation of phytate were increased with dose of exogenous phytase
- Low marginal effect of increasing dose of phytase
- Phytate degradation started in TMR when exogenous phytase was applied
- Ruminal pH and digestibility of NDF was not affected
Microbial phytase activity in the rumen

- *Selenomonas ruminantium*:
  - Primary producer of ruminal phytase
  - Cell-associated activity of phytase
  - Stimulated by starch
    (Yanke et al. 1998 & 1999)
Selenomonas ruminantium phytase

(Yanke et al. 1999)
Test of interaction between exogenous phytase and ruminal phytase activity

- 4 fistulated Holstein dairy cows in 4 x 4 latin square design
- 3-week periods: two weeks adaptation, one week sampling
- Dietary treatments:
  - Starch (corn meal) vs Fiber (soyhulls)
  - No phytase vs 3590 FTU/kg DM
No interaction between exogenous phytase and ruminal phytase activity

<table>
<thead>
<tr>
<th>Treatment</th>
<th>P-value</th>
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<tbody>
<tr>
<td>CHO (78 vs. 86%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Phytase (79 vs. 84%)</td>
<td>0.005</td>
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<tr>
<td>CHO x Phytase</td>
<td>1</td>
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</tbody>
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Conclusion

• Ruminal phytate degradation was increased by dietary starch and by exogenous phytase

• Phytate degradation started in TMR when exogenous phytase was applied

• Phytate degradation was improved by 10 -> 13 %-units