Plasma cholesterol and adaptation of metabolism and milk production in feed restricted cows

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Background: Metabolism and cholesterol during early lactation in dairy cows

- Adipose tissue is mobilized
- Increasing supply of NEFA
- Liver: oxidation of fatty acids or re-esterification to triglycerides (TG)
- TG synthesis exceeds export of TG as very low density lipoproteins (VLDL)

**Risk of fatty liver**

Modified from Kessler et al., JDS 2014 and Gross et al., PlosOne 2015
Objectives

Are cholesterol levels in early lactation related to short-term adaptations of metabolism and milk production?

- Early lactation with low cholesterol concentrations
- Exposure to a transient concentrate withdrawal (one week) that further aggravates energy deficiency
Material and Methods

- 15 multiparous Holstein dairy cows
- Experimental period 21 days (first week for adaptation) starting at 24±7 days in milk
- Pasture + additional concentrate in week 1 and 3 of the experiment; **concentrate withdrawal in week 2**
- Blood sampling daily, milk samples twice/day
- **Retrospective grouping** according to total cholesterol concentration (median: 3.36 mmol/l) in week 1
- Statistical analysis: Mixed models (SAS, v. 9.4), group, time fixed effects, cow random subject
Results

Total cholesterol

<table>
<thead>
<tr>
<th></th>
<th>H-Chol</th>
<th>L-Chol</th>
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<tbody>
<tr>
<td>Withdrawal of concentrate</td>
<td></td>
<td></td>
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<tr>
<td>Reintroduction of concentrate</td>
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</tbody>
</table>

- day: $P = 0.2658$
- group: $P < 0.0001$
- day*group: $P = 0.9997$
Results

Phospholipids

HDL

LDL

Free cholesterol

Cholesteryl esters
Results

Milk yield

Withdrawal of concentrate
Reintroduction of concentrate

* Different from day 1 in H-Chol (P<0.05)
# Different from day 1 in L-Chol (P<0.05)

- Milk yield (kg/d)
- Day of experiment

- H-Chol
- L-Chol

<table>
<thead>
<tr>
<th>day</th>
<th>P</th>
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<tr>
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<td>0.0001</td>
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<thead>
<tr>
<th>group</th>
<th>P</th>
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<tr>
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<td>0.1626</td>
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<table>
<thead>
<tr>
<th>day*group</th>
<th>P</th>
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<td>0.6601</td>
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</table>
Results

**Glucose**

*Different from day 1 in H-Chol (P<0.05)*

**Insulin**

*Different from day 1 in L-Chol (P<0.05)*
Results

NEFA

BHB

*Different from day 1 in H-Chol (P<0.05)

#Different from day 1 in L-Chol (P<0.05)
Results

Triglycerides

VLDL

Day of experiment

Withdrawal of concentrate

Reintroduction of concentrate

Triglycerides (mmol/L)

VLDL (mmol/L)

day: $P = 0.0698$

group: $P < 0.0001$

day*group: $P = 0.9766$

H-Chol

L-Chol
Results

ASAT

GGT

Withdrawal of concentrate
Reintroduction of concentrate

<table>
<thead>
<tr>
<th>Day of experiment</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
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<td>ASAT (U/L)</td>
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<tr>
<td>H-Chol</td>
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<td>L-Chol</td>
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| GGT (U/L)         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |
| H-Chol            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |
| L-Chol            |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |

Statistical analysis:

- day: $P = 0.8457$
- group: $P < 0.0001$
- day*group: $P = 0.9990$
- day: $P = 1.0000$
- group: $P = 0.1716$
- day*group: $P = 0.9999$
Conclusions

- Circulating **cholesterol levels** in early lactation are associated with the extent of short-term adaptation responses to energy availability:
  - but: no changes of lipoproteins and phospholipids during aggravated energy deficiency in early lactation
  - reduction and recovery of milk yield
  - adaptation of glucose, NEFA, BHB and insulin
  - Activity of ASAT
Thank you for your attention!