The relationship between feed efficiency & the expression of genes associated with appetite control in the hypothalamus & intestine of pigs

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An improvement of 0.1 in FE from weaning to sale equates to an approximate €2.00 increase in profitability per pig.

What is feed efficiency & what is the impact of improving it?

Feed consumed per kg of gain

Improving FE by 0.1 will result in approximately a 3.3% reduction in nutrient excretion.

What is driving the differences in feed intake and feeding behavior in pigs that differ in feed efficiency?
Neuropeptides & gut peptides in appetite control & feeding behavior

Objective
To examine the role of hypothalamic and gut peptide gene expression in the regulation of appetite and feeding behavior in pigs divergent in RFI

Hypothesis
The lower feed intake and lower feeding activity in LRFI pigs may be reflected in changes in the expression of genes involved in appetite control and feeding behavior when compared to HRFI pigs

Are changes in neuropeptide and gut peptide gene expression responsible for differences in feed intake and feeding behavior in pigs divergent in feed efficiency?
**Phenotypic identification of pigs divergent in feed efficiency**

<table>
<thead>
<tr>
<th>Day</th>
<th>0</th>
<th>28</th>
<th>56</th>
<th>83</th>
<th>110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pigs weighed weekly</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Start of trial (n=144) 28 sows</td>
<td></td>
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<tr>
<td>Pigs weaned (7.9kg ± 0.82)</td>
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</tr>
<tr>
<td>Pigs moved onto electronic feeders (n=70) (22.42kg ± 2.03)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start of measurement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MBW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RFI calculation</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Animals euthanized n=8 (HRFI) n=8 (LRFI)</td>
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</tr>
</tbody>
</table>

**Materials & Methods**

- 16 pigs n=8 (HRFI) n=8 (LRFI)
- RNA extraction
- Real-time QPCR
- NPY, AGRP, CART, POMC, MC4-R, NMB, HCRT
- CCK, GLP-1R, GLP-2R, GHRL, PYY, GCG, PP, OXN

**Animal performance**

- Average daily gain (P=0.19)
- Body weight (P=0.76)
- Average daily feed intake (P=0.88)
- Feed conversion ratio (P=0.99)
Feeding behavior

Feeding behavior

Neuropeptides in the ARC

NPY, AGRP, CART, POMC, MC4-R, NMB, HCRT
Gut peptide gene expression

CCK, GLP-2R, GHRH, PPY, GCG, PP, OXN

Duodenum
Jejunum
Ileum
NS

Summary

- LRFI pigs had lower feed intake than the HRFI pigs
- LRFI pigs had reduced feeding behavior activity
- Pigs divergent in RFI did not differ in the gene expression of the main hypothalamic neuropeptides
- LRFI pigs had lower gene expression of GLP-1R in both the jejunum and ileum

Conclusions

Conclusions


Organized involved in appetite control

(Ashima 2008)
### Correlations between feeding behavior & hypothalamic neuropeptides

<table>
<thead>
<tr>
<th>Structure</th>
<th>Time eating per day</th>
<th>Time eating per visit</th>
<th>Eating rate</th>
<th>Total eaten per day</th>
<th>No. of visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraventricular nucleus</td>
<td>-0.3</td>
<td>-0.05</td>
<td>-0.22</td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>CART</td>
<td>0.41</td>
<td>0.05</td>
<td><strong>0.63</strong></td>
<td>0.03</td>
<td>0.12</td>
</tr>
<tr>
<td>NPY</td>
<td>-0.31</td>
<td>-0.05</td>
<td>-0.13</td>
<td>0.21</td>
<td>0.28</td>
</tr>
<tr>
<td>POMC</td>
<td>0.19</td>
<td>0.32</td>
<td>-0.07</td>
<td>-0.3</td>
<td>0.38</td>
</tr>
</tbody>
</table>

### Correlations between feeding behavior & gut peptides

<table>
<thead>
<tr>
<th>Structure</th>
<th>Time eating per day</th>
<th>Time eating per visit</th>
<th>Eating rate</th>
<th>Total eaten per day</th>
<th>No. of visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duodenum</td>
<td>-0.02</td>
<td>0</td>
<td>0.03</td>
<td>0</td>
<td>-0.03</td>
</tr>
<tr>
<td>GLP-1R</td>
<td>-0.17</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.11</td>
<td>0.19</td>
</tr>
<tr>
<td>GLP-2R</td>
<td>-0.27</td>
<td>0.27</td>
<td>-0.39</td>
<td>-0.16</td>
<td>0.22</td>
</tr>
<tr>
<td>PPY</td>
<td>-0.26</td>
<td>0.15</td>
<td><strong>-0.52</strong></td>
<td>-0.24</td>
<td>-0.11</td>
</tr>
</tbody>
</table>

### Residual feed intake (RFI)

- RFI partitions feed intake into intake for body weight and body weight gain and a residual portion that is unrelated to growth and maintenance.
- RFI allows evaluation of variation in feed efficiency that can't be accounted for when using FCR or GTF.
Distribution of RFI

LRFI = -0.139 (n=27)
MRFI = 0.00 (n=26)
HRFI = 0.185 (n=20)