ISOLEUCINE, VALINE, AND LEUCINE REQUIREMENTS OF 6-19 KG PIGLETS


Dept. of Animal Science, Aarhus University, Foulum, DK-8830 Tjele, Denmark;
INRA, UMR1348 PEGASE, 35590 Rennes, France;
Pig Research Centre, Agro Food Park 15, DK-8200 Aarhus N, Denmark;
Ajinomoto Eurolysine s.a.s., 75817 Paris Cedex 17, France.
PROJECT OVERVIEW

› August 2012 – July 2015

› 3 dose-response studies (presented today)

› Metabolomics on blood/urine samples (in progress)
  › Identify metabolites which can be linked to performance

› Method development (late 2014)
  › Test a new method for estimating BCAA requirements using blood/urine metabolites identified by metabolomics
Reduced crude protein diets for piglets

- Health Issues
- Environmental concerns
- Reduce cost of the diet
- Less catabolism of surplus protein

- Less diarrhea in piglets and weaners
- Less N emission to the environment
- Less soy bean import
- Better energy efficiency
Amino acid ↔ Keto acid
- Val ↔ KIV
- Ile ↔ KMV
- Leu ↔ KIC

Keto acid → Energy
- Regulated by the same enzymes

Problem at BCAA imballance
- High Leu = Active enzyme
  - = Leu degradation 😊
  - = Val degradation! 😞
  - = Ile degradation! 😞
HYPOTHESIS

Different levels of BCAA

• Ile
• Val
• Leu

Unique catabolic metabolites

• Blood
• Urine

Physiological markers

• Animal performance
GENERAL METHODOLOGY

- 6 levels of SID BCAA:Lys
- 16 females pigs per level
- Start 1 week after weaning (7-9 kg)
- Individually penned
- Fed ad libitum for 2 weeks
- Weighing weeks 0, 1, and 2
- Blood and urine samples after weeks 1 and 2
DIET CHEMICAL COMPOSITION

- Danish recommendation
  - SID Ile:Lys = 0.53, SID Val:Lys = 0.67, SID Leu:Lys = 1.02
  - Lysine was 90-93% of the recommendation for 9-15 kg pigs
  - Based on 70% wheat, 10% barley, 10.5% HP300
  - Glutamic acid was added to provide similar crude protein
PERFORMANCE PARAMETERS

Average daily feed intake

Feed conversion ratio

Average daily gain
PLASMA AA CONCENTRATIONS

Ile  Val  Leu

0 0.2 0.4 0.6 0.8 1

0.42 0.46 0.5 0.54 0.58 0.62

EAAP, 2014. COPENHAGEN
PLASMA AND URINARY UREA NITROGEN

**Plasma urea nitrogen**

<table>
<thead>
<tr>
<th>SID Ile:Lys</th>
<th>0.42</th>
<th>0.46</th>
<th>0.50</th>
<th>0.54</th>
<th>0.58</th>
<th>0.62</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUN, mmol/L</td>
<td>2.5</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
<td>0.5</td>
<td>0</td>
</tr>
</tbody>
</table>

**Urinary urea nitrogen**

<table>
<thead>
<tr>
<th>SID Ile:Lys</th>
<th>0.42</th>
<th>0.46</th>
<th>0.50</th>
<th>0.54</th>
<th>0.58</th>
<th>0.62</th>
</tr>
</thead>
<tbody>
<tr>
<td>U:C, d8</td>
<td>60</td>
<td>50</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>U:C, d15</td>
<td>40</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Ile Val Leu
CONCLUSION

▶ This study
▶ 0.52
▶ Our 2012 study: 0.52

▶ Recommendations
▶ 0.52 INRA 2013, France
▶ 0.54 FEDNA 2013, Spain
▶ 0.53 VSP 2013, Denmark
PERFORMANCE PARAMETERS

Average daily feed intake

![Graph showing average daily feed intake (ADFI, g/day) for different SID Val:Lys ratios (0.58 to 0.78).]

Average daily gain

![Graph showing average daily gain (ADG, g/day) for different SID Val:Lys ratios (0.58 to 0.78).]

Feed conversion ratio

![Graph showing feed conversion ratio (FCR, g/g) for different SID Val:Lys ratios (0.58 to 0.78).]
PLASMA AA CONCENTRATIONS

Arg  Ile  Leu  Lys  Phe  Val  Ala  Glu  Gly  Ser  Pro

0.58 0.62 0.66 0.7 0.74 0.78
PLASMA AND URINARY UREA NITROGEN

Plasma Urea nitrogen

<table>
<thead>
<tr>
<th>PUN, mmol/L</th>
<th>0.58</th>
<th>0.62</th>
<th>0.66</th>
<th>0.7</th>
<th>0.74</th>
<th>0.78</th>
</tr>
</thead>
<tbody>
<tr>
<td>SID Val:Lys</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Urinary Urea nitrogen

<table>
<thead>
<tr>
<th>U:C, d8</th>
<th>0.58</th>
<th>0.62</th>
<th>0.66</th>
<th>0.7</th>
<th>0.74</th>
<th>0.78</th>
</tr>
</thead>
<tbody>
<tr>
<td>U:C, d15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ile  Val  Leu
MODELS

ADFI, g/day

SID Val:Lys

0.67 0.71

ADG, g/day

SID Val:Lys

0.67 0.71

FCR, g/g

SID Val:Lys

0.67 0.71

Ile Val Leu
CONCLUSION

› This study
› 0.70

› Recommendations
› 0.70 INRA 2013, France
› 0.69 FEDNA 2013, Spain
› 0.67 VSP 2013, Denmark
PERFORMANCE PARAMETERS

Average daily feed intake

Average daily gain

Feed conversion ratio
PLASMA AA CONCENTRATIONS

Ile  Val  Leu

0.7  0.8  0.9  1  1.1  1.2
PLASMA AND URINARY UREA NITROGEN

**Plasma urea nitrogen**

<table>
<thead>
<tr>
<th>SID Leu:Lys</th>
<th>PUN, mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>2</td>
</tr>
<tr>
<td>0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>1.1</td>
<td>1.25</td>
</tr>
<tr>
<td>1.2</td>
<td>2.5</td>
</tr>
</tbody>
</table>

**Urinary urea:creatinine**

<table>
<thead>
<tr>
<th>SID Leu:Lys</th>
<th>Urinary</th>
<th>U:C, d8</th>
<th>U:C, d15</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>0.8</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>0.9</td>
<td>10</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>1.1</td>
<td>0</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>1.2</td>
<td>0</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>
CONCLUSION

› This study: 1.00

› Recommendations
  › 1.01 INRA 2013, France
  › 1.00 FEDNA 2013, Spain
  › 1.02 VSP 2013, Denmark
CONCLUSIONS

- Optimum concentrations based on animal performance:
  - Isoleucine: 0.52 SID Ile:Lys
  - Valine: 0.70 SID Val:Lys
  - Leucine: 1.00 SID Leu:Lys

- Results are close to those reported by recent literature reviews

- Results and conclusions are sensitive to the choice of models
METABOLICOMICS

Samples
- Blood
- Urine

Data acquisition
- LC-MS
- LC-MS/MS

Preprocessing
- Peak detection
- Alignment
- Normalization

Chemometric Analysis
- PCA
- PLS

Biomarker identification and pathway
- KEGG
- Metlin

Ile Val Leu
AKNOWLEDGEMENT
THANK YOU FOR YOUR ATTENTION!

Jan.Noergaard@agrsci.dk
Elhama.soumeh@agrsci.dk
## Diet Chemical Composition

<table>
<thead>
<tr>
<th>Item</th>
<th>SID Ile:Lys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.42</td>
</tr>
<tr>
<td>Energy, MJ NE/kg</td>
<td>10.5</td>
</tr>
<tr>
<td>Crude protein, g/kg</td>
<td>163.0</td>
</tr>
<tr>
<td>Lysine (total), g/kg</td>
<td>12.3</td>
</tr>
<tr>
<td>SID Lysine, g/kg</td>
<td>11.4</td>
</tr>
<tr>
<td>Isoleucine, g/kg</td>
<td>5.6</td>
</tr>
<tr>
<td>Glutamate</td>
<td>34.4</td>
</tr>
</tbody>
</table>
## DIET CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>Item</th>
<th>SID Val: Lys</th>
<th>0.58</th>
<th>0.62</th>
<th>0.66</th>
<th>0.7</th>
<th>0.74</th>
<th>0.78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, MJ NE/kg</td>
<td></td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
</tr>
<tr>
<td>crude protein, g/kg</td>
<td></td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>177</td>
<td>177</td>
</tr>
<tr>
<td>Lysine (total), g/kg</td>
<td></td>
<td>11.8</td>
<td>11.8</td>
<td>11.8</td>
<td>11.8</td>
<td>11.8</td>
<td>11.8</td>
</tr>
<tr>
<td>SID Lysine, g/kg</td>
<td></td>
<td>10.6</td>
<td>10.6</td>
<td>10.6</td>
<td>10.6</td>
<td>10.6</td>
<td>10.6</td>
</tr>
<tr>
<td>Valine, g/kg</td>
<td></td>
<td>7.4</td>
<td>7.9</td>
<td>8.3</td>
<td>8.7</td>
<td>9.1</td>
<td>9.6</td>
</tr>
<tr>
<td>Glutamate</td>
<td></td>
<td>39.4</td>
<td>39.3</td>
<td>38.8</td>
<td>38.1</td>
<td>37.7</td>
<td>37.5</td>
</tr>
</tbody>
</table>
## DIET CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>Item</th>
<th>SID Leu:Lys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.70</td>
</tr>
<tr>
<td>Energy, MJ NE/kg</td>
<td>10.4</td>
</tr>
<tr>
<td>crude protein, g/kg</td>
<td>154.0</td>
</tr>
<tr>
<td>Lysine (total), g/kg</td>
<td>11.8</td>
</tr>
<tr>
<td>SID Lysine, g/kg</td>
<td>11.0</td>
</tr>
<tr>
<td>Leucine, g/kg</td>
<td>8.9</td>
</tr>
<tr>
<td>Glutamate</td>
<td>35.2</td>
</tr>
</tbody>
</table>