Effects of increasing phosphorus and calcium on growth performance and mineral status in weaned piglets

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Introduction
Phosphorus (P) and calcium (Ca) are essential minerals for adequate bone development in pigs. The aims were 1) to evaluate diets with increasing digestible P (dP) levels and a fix Ca to dP ratio on growth performance and mineral status in weaned piglets; 2) to compare the responses of physical measurement techniques representative for bone mineralization.

Material and methods
- Animals: 56 Swiss Large White piglets (26±1 d, 7.6±1.2 kg BW); 14 blocks according to litter, gender and BW. Grouped housing with automatic individual feed intake recording. Duration: 41 days.
- Diets: Ad libitum fed pelleted (<70°C) barley based diet. Including 500 FTU/kg phytase (equiv. 0.16 g dP/100 FTU). Ca to dP ratio set at 2.8:1.
- Treatments: 2.5, 3.5, 4.5 and 5.5 g dP/kg diet using monocalcium phosphate. Dietary Ca levels corrected using calcium carbonate.
- Bone measurements: Mineral contents in metacarpus III and IV; breaking strength, gravimetric density, and dual-energy X-ray absorptiometry (GE, i-DXA) bone mineral content and density on tibia.

Results
- Growth: Comparable (P>0.10) final BW (22.0, 0.84 kg; least square mean, SEM), BWG (345, 18.4 g/d) and FI (561, 26 g/d). Improved (P<0.01) FCR in 2.5 and 3.5 vs. 4.5 and 5.5 g/kg dP (1.58 vs. 1.72).
- Blood serum: Comparable (P>0.10) Ca, P contents and alcaline phosphatase activity.
- Bone mineralisation:

<table>
<thead>
<tr>
<th>Metacarpus III and IV</th>
<th>digestible P [g/kg diet]</th>
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<tbody>
<tr>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Ash [g/kg DM]</td>
<td>426</td>
</tr>
<tr>
<td>Zn [mg/kg DM]</td>
<td>139</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tibia</th>
<th>Breaking strength [N]</th>
<th>1178</th>
<th>1507</th>
<th>1619</th>
<th>1689</th>
<th>61.1</th>
<th>***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravimetric density [g/cm³]</td>
<td>1.28</td>
<td>1.31</td>
<td>1.33</td>
<td>1.34</td>
<td>0.004</td>
<td>***</td>
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</tr>
<tr>
<td>DXA Bone mineral content [g]</td>
<td>7.3</td>
<td>9.5</td>
<td>10.2</td>
<td>10.9</td>
<td>0.39</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>DXA Bone mineral density [g/cm²]</td>
<td>0.33</td>
<td>0.40</td>
<td>0.44</td>
<td>0.46</td>
<td>0.009</td>
<td>***</td>
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</tr>
</tbody>
</table>

Bone mineralisation relative to daily P-intake:

- Ash [g/kg DM]: 426–471 g/kg DM (P<0.001)
- Zn [mg/kg DM]: 139–129 mg/kg DM (P<0.001)
- Breaking strength [N]: 1178–1689 N (P<0.001)
- Gravimetric density [g/cm³]: 1.28–1.34 g/cm³ (P<0.001)
- DXA Bone mineral content [g]: 7.3–10.9 g (P<0.001)
- DXA Bone mineral density [g/cm²]: 0.33–0.46 g/cm² (P<0.001)

Conclusions
- The deteriorated FCR from 4.5 g dP/kg onwards may be due to the excessive dietary Ca.
- 3.5 g dP/kg were optimal as FCR was not deteriorated and bone ash and physical properties were close to maximas.
- Metacarpal Zn status was not antagonized by increasing dietary Ca and P.
- The DXA technique was successful to reflect values from more labor intensive measurements, such as bone breaking strength and gravimetric bone density in tibia from piglets.